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A Guide for Early Embedded Training Decisions

Second Edition

July 1996

Simulator Systems Research Unit

U.S. Army Research Institute for the Behavioral and Social Sciences

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Embedded Training (ET) is training built into or added to a weapons system. Although Army policy requires training developers to consider ET before other training options, effective implementation of this policy has been hampered by the lack of specific procedures to determine whether training should be embedded or not. This report provides a set of guidelines--in the form of detailed decision flowcharts--to assist training developers and engineers in making early ET decisions. Although information about task characteristics has traditionally determined selection of media for training, it is now considered less important in deciding when to use ET than the following factors:

- o policy;
- o system availability for training;
- o technical feasibility of ET implementation;
- o effects of ET on system reliability, availability, and maintainability;
- o impact of ET on system manpower and personnel requirements;
- o need for training-specific interface hardware;

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- o safety; and
- o cost-effectiveness.

These factors, which are incorporated in three sets of flowcharts, are designed to be used in different stages of the acquisition process. This guide is an updated version of the original, first published in June 1991. The guide was updated to conform to new materiel acquisition guidance (see DOD Directives 5001 and 5002). The guide was also reformatted and placed in a three-ring binder to make it easier to use.

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A Guide for Early Embedded Training Decisions

Second Edition

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Human Performance Effectiveness and Simulation

FOREWORD

The Army's need for a "top-down" approach for developing training systems to support new weapons systems was reported by the Army Science Board in 1985. In response to this need, the U.S. Army Research Institute for the Behavioral and Social Sciences is conducting research to develop and evaluate training design rules and guidelines. These rules and guidelines will be applicable early in the weapons system design process and will facilitate development of an integrated set of requirements for training devices, simulators, and simulations, including embedded training, for both weapons systems and units.

This report presents the results of one part of that process: the development of guidelines for deciding what training to embed in weapons systems and what to train by other means. Embedded Training (ET) is training that is built into or added to a weapons system. Army leadership has established policy that ET will be thoroughly evaluated and considered as the preferred alternative to other approaches to training. However, implementation of this policy has been hampered by the lack of specific procedures for determining what training should be embedded and what training should be provided by other means.

The work described in this report is part of the ARI research task entitled Technology Development for Simulated Training Environments, being conducted for the Army Project Manager, Training Devices (PM TRADE), by the PM TRADE Field Unit at Orlando, Florida (as it was, now Simulator Systems Research Unit) under a Memorandum of Understanding, "Expanded MOU Between PM TRADE and ARI," dated 14 Jul 86. An earlier version of the guide was published as ARI Research Product 91-14 in June 1991. This version conforms with revised materiel acquisition documentation. (See DOD Directives 5001 and 5002.) It has been reformatted to make it easier to use.

Although these guidelines have undergone extensive review, embedded training is a relatively new area and many lessons remain to be learned. To benefit from these lessons learned, the ET guidelines must be a living document. Users are encouraged to submit any problems in using the guidelines or suggestions for improvement to the authors. Comments should be addressed to Chief, Simulator Systems Research Unit, ATTN: PERI-IF, 12350 Research Parkway, Orlando, Florida 32826-3276.

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CONTENTS

	Page
1. INTRODUCTION	1
The Problem	3
2. BACKGROUND INFORMATION	7
Characteristics of a Successful Embedded Training System	9
Types of Embedded Training	10
Advantages and Disadvantages of Embedded Training	11
Underlying Principles	12
Assumptions of the Guidelines	13
3. HOW TO USE THIS GUIDE	15
Who Should Use This Guide?	17
Overview of the Structure	18
Phase I	20
Phase II	24
Phase III	25
Phase IV	27
Simulation-Based Training Alternative Cost Summary	28
Level of Analysis	29
Definitions	29
Recommendations	30
4. ET DECISION AID (PHASE I)	33
Phase I. Flowchart	35
Phase I. Block 1	36
Phase I. Block 2	38
Phase I. Block 3	40
5. ET DECISION AID (PHASE II)	43
Phase II. Flowchart	45
Phase II. Block 1	46
Phase II. Block 2	48
Phase II. Block 3	50
Phase II. Block 4	52
Phase II. Block 5	54
Phase II. Block 6	56
Phase II. Block 7	58

CONTENTS

Page

6. ET DECISION AID (PHASE III/IV) 61

Phase III/IV. Flowchart 63
Phase III. Block 1 66
Phase III. Block 2 68
Phase III. Block 3 70
Phase III. Block 4 72
Phase III. Block 5A 74
Phase III. Block 5B 76
Phase III. Block 6A 78
Phase III. Block 6B 80
Phase III. Block 7A 82
Phase III. Block 7B 84
Phase III. Block 8 86
Phase III. Block 9 88
Phase III. Block 10 90
Phase III. Block 11 92
Phase III. Block 12 94
Phase III. Block 13 96
Phase III. Block 14 98
Phase III. Block 15 100
Phase III. Block 16 102
Phase III. Block 17 104
Phase III. Block 18 106
Phase III. Block 19 108
Phase III. Block 20 110
Phase III. Block 21 112
Phase III. Block 22 114

7. SIMULATION-BASED TRAINING ALTERNATIVE COST SUMMARY . 117

8. REFERENCES 127

9. LIST OF ACRONYMS 131

APPENDIX A. ET CONSIDERATION FACTORS A-1

LIST OF FIGURES

Figure 1. Sample system missions, functions, and tasks 21

2. Blank training alternative summary matrix 22

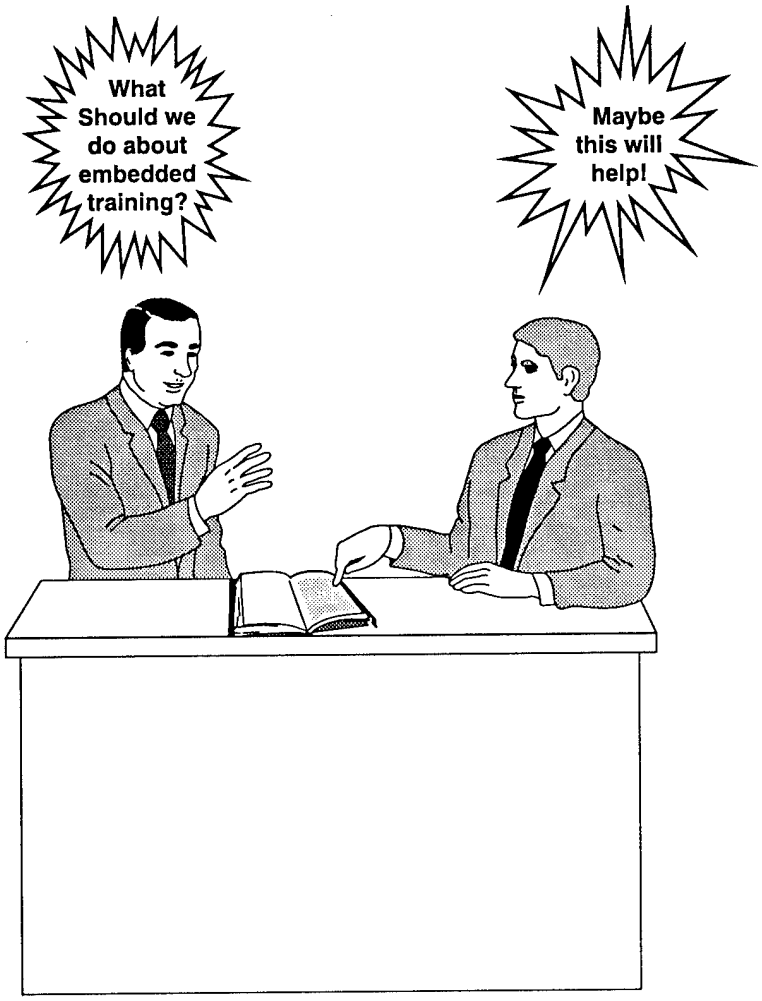
3. Sample training alternative summary matrix 23

4. Training alternative cost summary 121

A Guide for Early Embedded Training Decisions

Second Edition

SECTION 1. INTRODUCTION



INTRODUCTION

Embedded Training (ET) is defined as "training that is provided by capabilities designed to be built into or added into operational systems to enhance and maintain the skill proficiency necessary to operate and maintain that equipment end item" (DA, 1987). While the concept of ET has been in existence for some time, instances of its successful implementation in Army systems are relatively rare. The emphasis on ET is increasing, however, as a result of several changes in Army policy, practice, and weapons systems. First, realistic unit training is being emphasized as a means to better prepare our forces for combat. Second, overall cost reduction has become mandatory, and many of the costs resulting from the use of actual weapons systems for training, such as increasingly powerful and sophisticated ammunition and the ranges on which it can safely be fired, are increasing. Third, more systems have embedded computer capability which can support training if designed appropriately.

Aware of these factors, the Vice Chief of Staff, Army, and the Under Secretary of the Army stated as policy in March 1987 that

> *An embedded training capability will be thoroughly evaluated and considered as the preferred alternative among other approaches to the incorporation of training sub-systems in the development and follow on Product Improvement Programs of all Army materiel systems.*

However, effective implementation of this policy has been hampered by the lack of specific procedures for determining what training should be embedded and what should be provided by other means. This guide is designed to help the user to determine, early in the acquisition process, what training to embed into the prime system.

The Problem

In one sense, ET can and should be considered as any other training medium. The worth of ET for a particular application should be determined on the basis of its cost and training effectiveness relative to alternative means of providing the training. But ET presents unique problems for making decisions about training because the capability to provide embedded training must be built into the prime system. The requirements for embedded training must therefore

be determined early enough to be included in the prime system design. However, ET should also fit into an overall macro training strategy which matches the tasks to be trained with the training media which will be used to train each. When conducting concept formulation for a "stand-alone" training device or simulator, the concept formulation process for the device is typically far enough behind the concept formulation process for the prime system itself that adequate design information is available. With ET this is not possible. The design of the ET is a part of the design of the prime system itself and must proceed concurrently. The task-level information historically used to make training media decisions is not usually available in time to assist in making embedded training decisions.

This guide is designed to assist in determining, early in the acquisition process, what training should be embedded in the prime system and what should be provided by other means. It treats these decisions as a phased process which is linked to information availability. Tentative decisions must be made initially and then revised as more information becomes available. The guide defines four decision phases. For each phase it describes

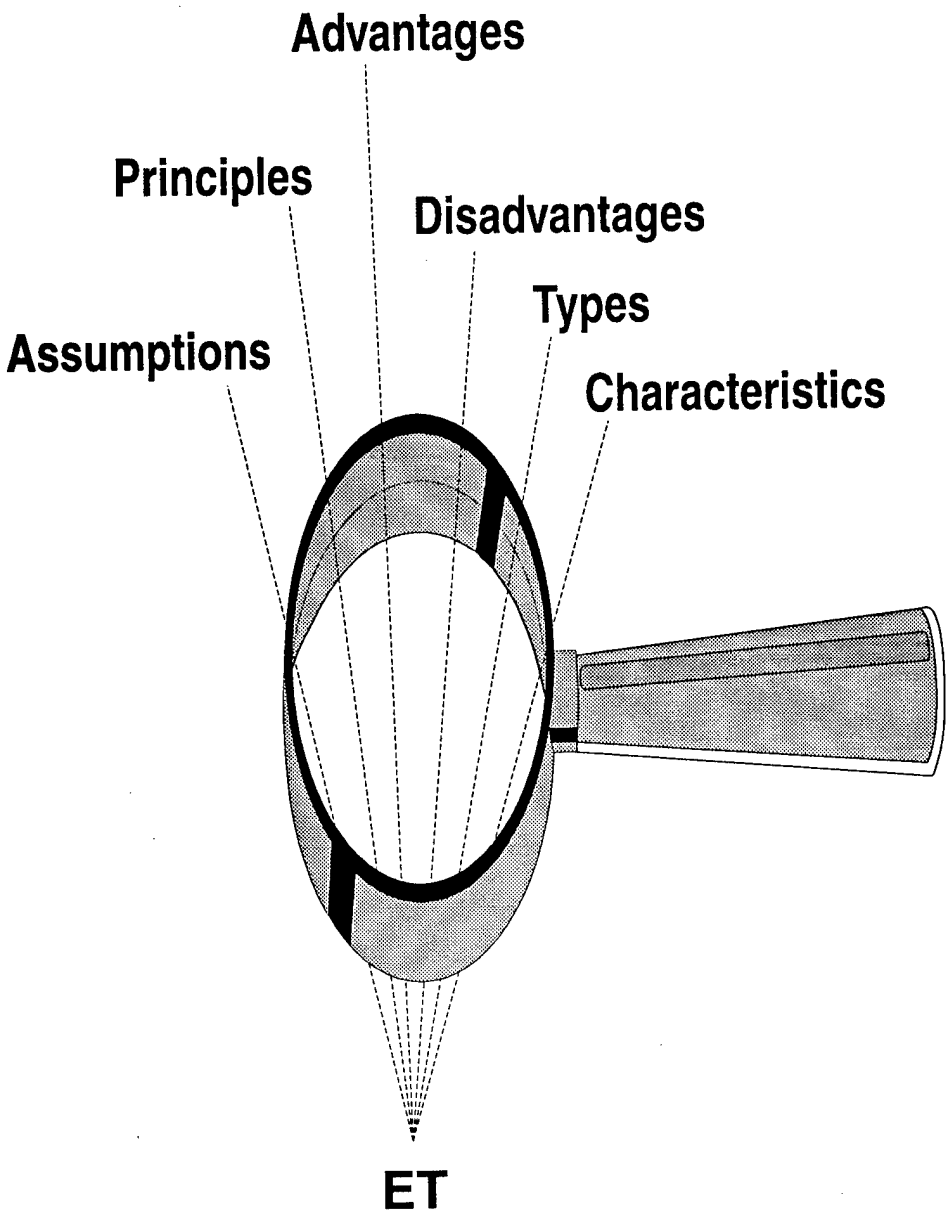
- When the phase occurs
- The information that is required for decision making
- The major questions that are to be answered
- A set of decision flowcharts for arriving at the answers to those questions
- The resulting products

This guide is divided into seven sections. The first three sections give the user the necessary information to use the decision-making tools included in the last four sections.

- Section 1 provides the introduction.
- Section 2 provides necessary background information, such as definitions and assumptions.
- Section 3 provides a description of the four decision phases.
- Sections 4 through 6 provide the decision flowcharts and supporting textual descriptions. (The flowcharts for Phases III and IV are identical.)
- Section 7 provides worksheets to support a cost comparison of simulation-based training alternatives.

The decision flowcharts, cost worksheets, and accompanying text will lead to training media decisions that are based on all of the available information and can be easily presented and defended.

SECTION 2.
BACKGROUND INFORMATION



BACKGROUND INFORMATION

Characteristics of a Successful Embedded Training System

Usually the ET system will be only one part of a total training system, which may include various training media. To be successful it must include only those tasks, functions, or missions to which its characteristics are best suited. Other training media should be used if they can train more effectively than ET at a lower cost.

Successful ET requires more than merely providing the soldier with an opportunity to practice with the prime system. If properly designed, it can be used to provide initial acquisition as well as sustainment training. According to Strasel, Dyer, Roth, Alderman, and Finley (1988), an ET system which can accomplish this must include the following features:

- A means of assessing soldier performance
- A means of providing feedback to the soldier to reinforce and improve correct performance
- A means of record keeping to allow the management of individual and collective training and identify deficiencies requiring additional training

At the heart of a typical ET system is a computer-based system, either integral to or adjunct to the prime system, which, when activated, interrupts or overlays the system's normal operational mode to enter a training and assessment mode. The ET system also includes the facilities, expendable supplies and materials, and personnel required to provide embedded training. Usually ET will not satisfy all of the training needs for a system, individual, or unit. The ET system will therefore be only one component of a total training system. A fully functioning ET system should then (Strasel et al., 1988)

- Generate target or threat data (or other operational input data peculiar to the system)

- Feed these data into and through the operational equipment to the system operator(s) or maintainer(s) by means of their normal displays and indicators

- Present the input data so they realistically depict what would occur in operational use of the system against a real threat, to include the capability for degraded modes of operation

- Require the operator(s) or maintainer(s) to perform their normal tasks and duties in response to the simulated inputs

- Simultaneously assess and record the performance of the operator(s) or maintainer(s) and react to that performance as the real threat would, thereby providing realistic feedback on the accuracy and appropriateness of the performance

- Provide an appropriate level of performance measurement and recording to allow both individual feedback after a session and semi-permanent records of performance to provide for cumulative or aggregate records (for individuals, crews, or even units) over time

- Provide training according to both a macro and micro training device strategy. The macro training device strategy identifies the training devices (including embedded training) required for a new prime system, the tasks each will be used to train, and the circumstances under which each will be employed. A micro training device strategy (one for each device) indicates how each device will be employed to produce the desired training results.

Types of Embedded Training

These guidelines consider three types of ET which are defined below. They share the common characteristic that the soldier is trained using the controls and displays of the actual equipment. They differ along a continuum in the extent to which the embedded training system is fully contained within the prime system. The three types of ET listed here represent discrete points along an ET continuum that includes a potentially unlimited number of ET architectural types.

Fully Embedded. All training features, except for perhaps easily installed training software or courseware, are fully contained in the prime system itself. They go to war with the system. They meet the prime system Reliability, Availability, and Maintainability (RAM) requirements. Fully embedded ET on a vehicle could train while the vehicle is moving, as in tactical engagement simulation. Fully embedded training is usually distributed with the prime system on a "one-for-one" basis.

Appended ("Strap-On"). Appended ET can be installed on or attached to the prime system when needed and removed when it is not. It will nevertheless likely require permanent, designed-in components (such as sensors, mounting brackets, and connectors). Appended ET could be used in assembly areas or in close proximity to combat. It could go to war with the system if it were so designed, although that is not a necessary characteristic of appended ET. It could train "on the move." Ruggedization may be required. One embedded training system could serve multiple prime systems of the same type, but only one at any given time.

Umbilical. Umbilical ET is similar to appended, but involves, in addition, physical connection(s) to external components, such as a computer, communications system, or Instructor/Operator console. As with appended ET, it is likely to require some built-in features to interface with the external components of the system. Umbilical ET may interconnect many systems, as in simulated networking for force-on-force training. Umbilical ET is not a go-to-war training system. It cannot train "on the move." Ruggedization is unlikely to be required. One umbilical system can serve multiple prime systems of the same type. It is also possible for an Embedded Training Systems (ETS) to support multiple prime systems which are part of a family of systems. For example, an umbilical ETS could be used to provide tactical training for armored vehicle systems.

Since these types differ along a continuum, is it possible to conceive of ET which is not easily classified, such as an on-board ET component which communicates with an external component via radio or infrared transmission, rather than through a physical connection.

Advantages and Disadvantages of Embedded Training

While the advantages of embedded training will depend on the specific application, the following *advantages* are generally claimed (Finley, Alderman, Peckham, & Strasel, 1988).

- The training capability is fielded concurrent with the prime system.
- The capability to provide refresher and sustainment training capability is resident in the unit.
- The unit training management burden can be reduced.
- Training is standardized across units.
- As a by-product, high-quality job aids for the system user could be developed easily from the ET materials.
- ET may reduce wear and tear on some prime system components (e.g., on gun tubes, autoloaders, power-train components, and suspension

systems), thereby decreasing maintenance costs and manpower requirements.

- It is potentially cost effective through the reduced need for stand-alone training devices.

Similarly, the following *disadvantages* are generally claimed.

- The prime system is required in order to conduct training. Additional systems may be required solely for the purpose of providing training.
- Training components may be required to withstand more extreme physical conditions (shock, vibration, temperature extremes, etc.) than they would be if they were to be simply incorporated into a stand-alone device. They may need to be hardened or ruggedized, and therefore may be more expensive than they would otherwise need to be.
- ET may cause additional "wear and tear" on some prime systems components (e.g., on prime systems electronics, switches, and controls), thereby increasing maintenance costs and manpower requirements.
- ET may not be available during mobilization, particularly if a unit's personnel and equipment are transported separately.
- When the prime system is stored as Prepositioning of Materiel Configured to Unit Sets (POMCUS) stock, the training system will be unavailable to units until their arrival at the storage sites.
- Training components may take up space and add weight to the prime system.
- There are potential safety hazards, particularly where system movement or weapons firing, either real or simulated, is required.

Underlying Principles

The guide has been developed in accordance with the following principles:

- The decision process must be phased and linked to information availability. Tentative decisions must be made initially, and then revised as more information becomes available.
- Early decisions should be biased in favor of the use of ET, because it is easier to delete a requirement for ET than to add one after prime system design has begun. Early decisions should also favor ET because Army policy directs that ET be considered as the preferred training alternative.

- The specific tasks that the soldier must perform and specific prime system characteristics are only two of the factors which should affect the media selection decision.

Other factors which affect media selection and which are represented by the questions comprising the decision charts are described in Appendix A, ET Consideration Factors.

Assumptions of the Guidelines

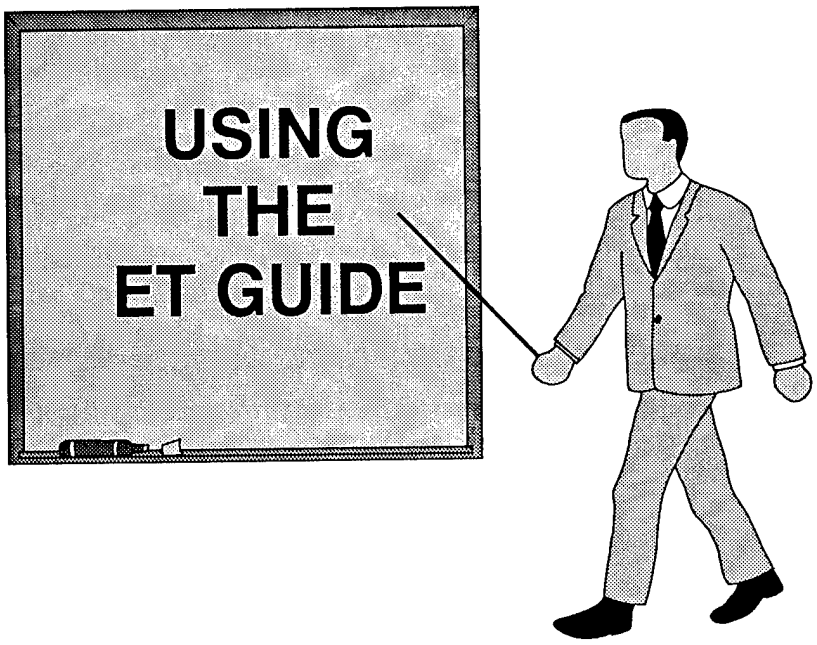
In order to develop these guidelines it was necessary to make certain assumptions about the training effectiveness of alternative training media, a priori priorities for the use of alternative training media, and maintenance philosophies. These assumptions are presented in the following paragraphs.

Given that the minimum requirements for their use are met, stand-alone simulators and devices (SAD), appended training devices, and all forms of embedded training can be developed to have equivalent training effectiveness. These various simulation alternatives may, however, differ in terms of their efficiency (time required to train) or cost effectiveness.

If maintenance of the training system is required to preserve the combat capabilities of the prime system, or if the maintenance must be performed in a combat environment, then military ("green suit") maintenance is preferred, as long as the maintenance can be performed without increasing manpower or skill requirements. In other situations, contract maintenance is preferred. However, a decision to use contract maintenance must consider the cost impact in Phases III and IV.

Embedded training is the preferred means of providing training. (This is Army policy.) In the absence of any evidence indicating that a particular training approach is preferred, either because it best satisfies the training requirements or because it is most cost effective for a particular application, the order of preference (from highest to lowest) is as follows: fully embedded, appended embedded, umbilical, appended, and stand-alone simulators and devices, with the last two being equal.

SECTION 3.
HOW TO USE THIS GUIDE



How To Use This Guide

Who Should Use This Guide?

The development of embedded training (ET) requires teamwork. The Prime System Project Manager (PM), the Directorate of Combat Developments (DCD), the Directorate of Training and Doctrine (DOTD) at the proponent TRADOC school, and the Simulation, Training, and Instrumentation Command (STRICOM) each play a key role.

The Prime System PM has overall responsibility for providing the field with a prime system that includes a total training package, including system training devices. This training package may include system training devices and embedded training. The PM provides, on a continuing basis, information about the design and operation of the system to other team members. He should be familiar with the rationale for the decisions about ET made for his system. Once the contract for the development of the prime system is under way, the PM is responsible for providing information about the design and operation of the system to other team members.

The Directorate of Combat Developments at the proponent school identifies the requirements for the prime system and its employment. These include items such as a description of the need to be met by the new system, a description of its employment, identification of operator and maintainer MOS, and establishment of a maintenance concept. DCD personnel serve as a source of information for users of this guide, but are not considered primary users.

The Directorate of Training and Doctrine, using inputs from the other team members, develops both macro and micro training device strategies. The Training Developer should also identify the tasks to be trained (conditions and standards); a target audience description (MOS, active or reserve component); skills, knowledge, and job performance specifications; safety and environmental considerations; the proposed training environment (local training area, garrison, or TRADOC school); training constraints; a list of the essential functional characteristics of the device; the proposed operational mode summary/mission profile; and the RAM requirements of the device. (Task analytic information may be provided by the prime system contractor.) DOTD personnel constitute a major audience for this guide.

STRICOM conducts concept formulation for all system and nonsystem training devices, included embedded training. Using the inputs provided by other team members, STRICOM develops conceptual approaches for meeting training device requirements and provides cost estimates for those approaches. The result is an agreed-upon "Best Technical Approach" for a training device. The concept formulation process for the embedded training system should proceed concurrently with the concept formulation for the prime system. Close coordination between STRICOM and the prime system program manager is essential to the overall concept formulation process. STRICOM personnel and their contractors constitute the second major audience for this guide.

Participant roles are described more fully by the U.S. Army Training Support Center Devices Management Directorate (1989).

Overview of the Structure

Sections 1, 2, and 3 of this guide present the definitions, assumptions, and an overview of the procedures used. Before using the decision aids, the analyst should become familiar with them.

Sections 4 through 7 of this guide contain detailed guidance for making early decisions about ET. Sections 4, 5, and 6 consist of decision flowcharts which will lead to training media recommendations. Phase I and Phase II flowcharts are presented in Sections 4 and 5, respectively. (Phases are defined later in this section.) The flowcharts for Phases III and IV are identical and are presented in Section 6. Section 7 contains a worksheet to be used to estimate costs for training media alternatives. The following information is provided for each phase:

- When the activities in that phase should be undertaken relative to the prime system acquisition process
- The information that should be obtained before the flowcharts for that phase are used
- The major questions to be answered during that phase
- The expected products of that phase

Phases are always designated by Roman numerals. The decisions flowcharts for each phase are presented as a series of blocks which are identified by Arabic numerals. Thus Phase III, Block 2 is the second block of the Phase III analysis. The descriptions of the decision flowcharts for each phase are preceded by a chart which describes the relationships among the blocks.

The cost analysis worksheet can be completed as part of the analysis of any phase. However, it is unlikely that the necessary information will be available, or that the training alternatives will be well enough defined, for a cost analysis to be

performed prior to the Phase III analysis. It should be completed as part of the analyses for Phases III and IV.

Different projects may begin this analysis with the prime system at different stages of development. The description of the various phases is used to determine the appropriate phase in which to begin the analysis. Selection of a phase is based on two factors:

- The status of the prime system relative to acquisition milestones
- The availability of information and data required to support the analysis

The latter is the more important. The key determinant is the availability of the necessary information. Complete task information is not expected to be available in the early phases. However, combat and training developers could begin to make educated guesses about operator and maintainer tasks based on preliminary information about combat tasks and system design plans. The more information that can be gathered early in the development of the prime system, the better the basis for making embedded training decisions.

Conducting the analysis in each phase will result in tentative conclusions. The results of each analysis should be incorporated into the system training plan (STRAP) for the prime system. The STRAP will also provide a source of information for embedded training decisions during later phases of your analysis. The availability of additional information will trigger initiation of the next phase. With a few exceptions, the logic flow in one phase does not generally differ depending on the conclusions reached in the previous phase. In this sense the phases are independent. Since the underlying logic of the analysis remains the same across the phases, and many of the questions are repeated across phases, contradictory results are unlikely. However, results may differ if the prime system requirements or concept changes, or as subsequent analyses are carried out at progressively greater levels of detail. In the unlikely event that contradictory results are obtained across phases, the recommendations of the later phase should take precedence because they are presumably based on more complete information. Recommendations from previous phases may need to be taken into account, however, if issues related to policy or the training environment are crucial to the selection of training media.

Not all of the required information may be available when it is needed, and the information that is available may sometimes be subject to change, ambiguous, or not as objective or rigorous as is desired. In such cases rough estimates, expert opinion, or "rules of thumb" will have to substitute until better information is available.

Phase I

Timing. *Phase I activities should be conducted during the Concept Exploration and Definition Phase (between Milestone 0 and Milestone I) for the prime system.* As with all of the phases of the ET decision process, the most important factor with regard to the timing is the availability of the necessary information—not an acquisition milestone.

Information Required. Information required consists of

- General policy and guidance documents regarding both the prime system and its supporting training system
- A copy of the Blueprint of the Battlefield, the mission need statement for the prime system
- The expected acquisition schedule for the prime system

A performance requirements taxonomy may be useful but is not required. One such taxonomy is provided by Kaplan and Crooks (1980). A performance requirements taxonomy provides a way to break down prime system missions into functions and tasks to be performed by operators and maintainers. Sample missions, functions, and tasks are shown in Figure 1. *Phase I analyses should be conducted at the system or mission level of detail, depending on the information, time, and resources available.*

Major Questions. These are the major questions to be answered during Phase I. The question numbers correspond to the flowchart block numbers in Section 4 of this guide.

1. Do training policies, goals, or constraints favor specific simulation alternatives?
2. Can ET be integrated into the prime system without interfering with operational capabilities?
3. Do Manpower, Personnel, and Training (MPT) requirements limit the simulation alternatives?

The answers to these questions are obtained by working through the decision flowcharts in Section 4 of this guide.

Products. *The major product created during Phase I is a matrix showing the system- or mission-level activities that should be considered for training by specified training alternatives, based on training policy and general system requirements.* If the analysis is conducted at the system or mission level, this matrix will also be at the system or mission level. Figure 2 shows a sample blank matrix for recording and presenting this information. Figure 3 shows a sample

SYSTEM MISSIONS

Armored Vehicles

1. Destroy fixed emplacements.
2. Destroy armored vehicles.
3. Destroy enemy personnel.
4. Destroy/disrupt enemy aircraft.
5. Suppress/disrupt enemy activity.
6. Serve as a platform for mounted attack.
7. Transport troops/materiel.
8. Protect crew/passengers/materiel from enemy action.

Infantry Weapons

1. Destroy enemy vehicles.
2. Destroy low-flying enemy aircraft.
3. Destroy fixed emplacements.
4. Destroy enemy troops.
5. Disrupt/suppress enemy activity.
6. Provide illumination.
7. Protect operator/crew from enemy action.
8. Conceal friendly forces by making smoke.

SYSTEM FUNCTIONS AND TASKS

Navigation

1. Select appropriate maps and/or navigation aids.
2. Identify present location.
3. Identify destination.
4. Select travel route.
5. Estimate time of arrival and fuel requirements.
6. Travel designated route.
7. Identify position or route at specified times/locations.

Target Acquisition

1. Detect target(s).
2. Identify target(s).
3. Select target(s) and target order.
4. Orient weapon system in general firing position.
5. Determine range of target.
6. Aim weapon system. This involves a procedure which results in the system being adjusted for the azimuth and elevation of the target.
7. Illuminate or designate target.
8. Adjust aim, following miss.
9. Shift to second target.

Figure 1. Sample system missions, functions, and tasks (from Kaplan and Crooks, 1980).

TRAINING ALTERNATIVE SUMMARY MATRIX

MISSION, FUNCTION, OR TASK	AET	ET			APPENDED DEVICE	SAD	CBI	CLASSROOM
		FULLY	APPENDED	UMBILICAL				

LEGEND

P = PREFERRED
R = RECOMMENDED
A = ALTERNATIVE
E = EXCLUDED

SAD = STAND-ALONE DEVICE
CBI = COMPUTER-BASED INSTRUCTION
AET = ACTUAL EQUIPMENT TRAINING

Figure 2. Blank training alternative summary matrix.

TRAINING ALTERNATIVE SUMMARY MATRIX

MISSION, FUNCTION, OR TASK	AET	ET			APPENDED DEVICE	SAD	CBI	CLASSROOM
		FULLY	APPENDED	UMBILICAL				
TARGET ACQUISITION		R	R					
NAVIGATION							P	P
VEHICLE MANEUVERING						R		
WEAPONS FUNCTION MANAGEMENT		R	R	R				

LEGEND

P = PREFERRED
R = RECOMMENDED
A = ALTERNATIVE
E = EXCLUDED

SAD = STAND-ALONE DEVICE
CBI = COMPUTER-BASED INSTRUCTION
AET = ACTUAL EQUIPMENT TRAINING

Figure 3. Sample training alternative summary matrix.

matrix which has been completed to show the results of a Phase II analysis of four prime system functions: navigation, vehicle maneuvering, target acquisition, and weapons function management. Other products created in Phase I are a list of constraints imposed on the training system by policy directives, and indication of whether acquisition milestones permit designing the prime system to accommodate ET.

Phase II

Timing. *Phase II activities are conducted between Milestone 0 and Milestone I of the prime system acquisition—during the Concept Exploration and Definition Phase.* Phase II activities may be conducted in close succession to Phase I if the information required for Phase II analysis is available.

Information Required. Information required consists of

- The information obtained for Phase I analysis
- Data on the training environment
- Information resulting from the conduct of an Early Comparability Analysis (ECA), if performed

ECA is a front-end analysis tool used to identify tasks which are costly in terms of manpower, personnel, or training requirements (U.S. Army Personnel Integration Command—Soldier Support Center, 1987). *Phase II analyses should be conducted at the mission or function level of detail, depending on the information, time, and resources available.*

Major Questions. These are the major questions to be answered during Phase II. The question numbers correspond to the flowchart block numbers in Section 5 of this guide.

1. Do safety and training requirements suggest ET or other simulation alternatives?
2. Can the prime system support ET, given MPT and RAM requirements?
3. Are other training alternatives supportable in terms of MPT and training facility requirements?
4. Which types of ET or simulation alternatives meet institutional training requirements?
5. Do unit training requirements suggest ET or other simulation alternatives?

6. Will the prime systems or their individual workstations be available for a sufficient amount of time to support ET?

7. Which types of ET meet unit training requirements?

The answers to these questions are obtained by working through the decision flowcharts contained in Section 5 of this guide.

Products. *The primary product of Phase II is an updated matrix showing what training should be considered for delivery by each training alternative.* Institutional and unit training are considered separately. The level of detail at which the results are presented will be the same as the level of detail of the input (i.e., mission level or function level). Other products include an indication of the impact of training alternatives on **MPT** requirements and **RAM** requirements, identification of the need and opportunity for unit training, and identification of the need for mobile and transportable training systems.

Phase III

Timing. *Phase III should be conducted as early as Milestone I but before Milestone II, i.e., during the Demonstration and Validation Phase of the prime system acquisition process.* Milestone I, Concept Demonstration Approval, is the decision phase for entry into the Concept Demonstration and Validation Phase of the acquisition.

Information Required. Information required consists of

- The information obtained for Phase I and Phase II analyses
- The prime system operational requirements documents
- The locations and structure of units expected to receive the prime system and the training facilities and resources available to the units
- A description of the prime system concept as produced by the concept formulation process
- Detailed information about the predecessor system, if there is one
- The results of a HARDMAN analysis, if any (Parrish, 1990)
- A description of the soldiers who will operate and maintain the prime system

The analysis should be conducted at the function or task level of detail, depending on the information, time, and resources available.

Major Questions. These are the major questions to be answered during Phase III of the analysis. The question numbers correspond to the flowchart block numbers in Section 6 of this guide.

1. Do safety or security concerns preclude the use of the prime system in training?

2. Do the skills and knowledges to be taught suggest ET?

3. Do the numbers of trainers or support personnel allowed by requirements documents limit or preclude ET use?

4. Will the range and training facilities be available to support ET?

5. Can the minimum requirements for a fully embedded training system be met?

6. Can the minimum requirements for an appended ET system be met?

7. Can the minimum requirements for an umbilical type embedded training system be met?

8. Will prime systems operations adversely affect ET and vice versa?

9. Does the embedded training system require visual system or motion system simulation?

10. Does the prime system have general or specific advantages for ET alternatives?

11. Is a system retrofit necessary in order to use ET?

12. Can the RAM requirements associated with embedded training be met?

13. Will the soldiers and prime systems be available for sufficient time to meet ET requirements?

14. Are the prime systems or their individual workstations available at training sites to support ET?

15. Does the manner in which the training system must be maintained affect training system selection and vice versa?

16. Does the number of trainers or support personnel allowed by requirements documents limit the use of SAD or appended training devices?

17. Will range and training facilities be available for SAD and appended training?

18. Can weapon system motion and direct vision be simulated in a SAD?

19. Would an appended training system interfere with prime system operation?

20. Can appended training RAM requirements be met? Can prime system availability meet training requirements?

21. Can SAD meet RAM and availability for training requirements?

22. Is actual equipment training (AET) a workable alternative?

The answers to these questions are obtained by working through the flowcharts in Section 6 of this guide.

Products. *The major product created during Phase III is a matrix showing the tasks or functions which should be assigned to each training alternative.* Other products include determination of the availability of the facilities and personnel (to include maintenance) for each training alternative, determination of the capability of the prime system to support ET, and the identification of the requirement to simulate direct vision and motion. The Training Alternative Cost Summary should also be completed as part of the Phase III analysis.

Phase IV

Timing. *The Phase IV analysis should be conducted during the Concept Demonstration and Validation Phase of the prime system acquisition cycle, which occurs between Milestone I and Milestone II.* The decision flowcharts for Phase IV are identical to those for Phase III. What differs is the information available to make ET decisions. Phase IV should be conducted whenever new information becomes available that could alter the results obtained during the Phase III analysis. The need for Phase IV analysis should be considered prior to each Milestone Review after Milestone I.

Information Required. Information required includes

- The information obtained for Phase I, II, and III analyses
- Data and information from simulations, mock-ups, testbeds, and tests and evaluations

Note that questions or uncertainties arising during Phase III analyses can be used to identify information required from such simulations and testbeds. *The analysis*

should be conducted at the task level of detail, depending on the information, time, and resources available.

Major Questions. *The major questions are the same as for Phase II, but should be answered using the additional data and data sources now available.* This information, as well as that from previous phases, can be used to design the ET system.

Products. *The major product created during Phase IV is an updated matrix showing the tasks or functions which should be trained by each training alternative.* Other Phase III products are updated. The Training Alternative Cost Summary should also be completed as part of the Phase IV analysis.

Simulation-Based Training Alternative Cost Summary

Timing. *The Training Alternative Cost Summary is usually completed in conjunction with the Phase III and IV analyses.* It considers costs associated with the training alternatives recommended as the result of working through the decision flowcharts. An asterisk on a flowchart designates a cost factor that should be considered in completing the cost summary worksheet. The worksheet also lists other cost factors not directly addressed by the flowcharts.

Information Required. The information required includes

- Cost data from predecessor systems, if they exist
- Cost factors identified in completing the flowcharts
- Basis of Issue Plan, if available
- Baseline cost estimate, if available

The decision flowcharts for each phase should have been completed before beginning the Training Alternative Cost Summary.

Major Questions. These are the major questions to be answered for the Simulation-Based Training Alternative Cost Summary.

1. What is the cost of designing and developing the training subsystem for each training alternative?
2. What is the cost of acquiring the training subsystem for each training alternative?
3. What is the annual cost of maintaining each training alternative?
4. What is the annual operation and support cost for each training alternative?

Products. *The major products are cost estimates for each training alternative.*

Level of Analysis

A key consideration in using this guide is the level at which the analyst works through the decision flowcharts and at which decisions are made. Should it be at the system level or at a lower one, such as mission, function, or task level? The general answer is that the analysis is conducted at the most detailed level for which supporting information and data are available, but not at a more detailed level than is needed. While the level at which the analysis is conducted may be constrained by the time and resources available, Phase I analyses are probably best conducted at the system or mission level, Phase II at the mission or function level, Phase III at the function or task level, and Phase IV at the task level.

If it has been determined that some elements (functions, tasks, etc.) are to be trained by the same methods (such as all troubleshooting tasks), then those elements should be combined for purposes of analysis. Elements may be divided (e.g., missions broken down into functions) during the course of the analysis if it becomes apparent that this would improve the analysis. Subdivision might, for example, permit better utilization of existing facilities or the advantages of specific training approaches. The purpose of the analysis is not to identify the single best training method, but to identify the best combination of training methods.

Definitions

Specialized terms and acronyms used in the flowcharts are defined below.

Appended Training Device. A training device that can be installed on or attached to the prime system when it is needed and removed when it is not. An appended training device is designed to be used with a prime system which either is already fielded or is so advanced in the design process that integration of the training device is not possible. In contrast, appended embedded training is designed concurrently with the prime system, either as part of the original development or as part of an improvement program. A training need could be met through appended embedded training if it were considered sufficiently early in the prime system design (or improvement) process, and through an appended training device if it were not.

Embedded Training. Training that is designed to be built into or added to operational systems to enhance and maintain the skill proficiency necessary to operate and maintain that equipment end item.

Instructor/Operator (Instr/Op). An individual who initializes and operates a simulator, training device, or embedded trainer; performs roles as required in simulated exercises; and briefs, debriefs, and tutors the students.

Manpower, Personnel, and Training (MPT). That set of resources which consist of the number of military or civilian personnel (spaces) having the appropriate skills (faces) and training to support an activity.

Reliability, Availability, and Maintainability (RAM). Measures of system effectiveness usually defined in terms of mean time between failures (reliability), percentage of time in a mission committable status (availability), and mean time to repair (maintainability).

Stand-Alone Devices (SAD). Simulators or training devices which are not part of the prime system and do not depend on prime system operation to train.

Training Alternatives. The following set of methods for providing training: Actual Equipment Training (AET), Embedded Training (Fully embedded, Appended, or Umbilical), Appended Devices, Stand-Alone Devices, Classroom Instruction, and Computer-Based Instruction (CBI).

Simulation Alternatives. The following subset of training alternatives: Actual Equipment Training (AET), Embedded Training (Fully embedded, Appended, or Umbilical), Appended Devices, and Stand-Alone Devices.

Recommendations

Within the flowcharts, recommendations are placed in oval "balloons." The explanation of each recommendation is as follows:

"x is an alternative"—training approach or medium x meets minimum requirements and should be considered a possible training alternative until additional analyses are completed.

"x is a recommended alternative"—training approach or medium x exceeds minimum requirements. It is preferred to other alternatives which are not "recommended alternatives."

"use x"—training approach or medium x is the preferred training alternative.

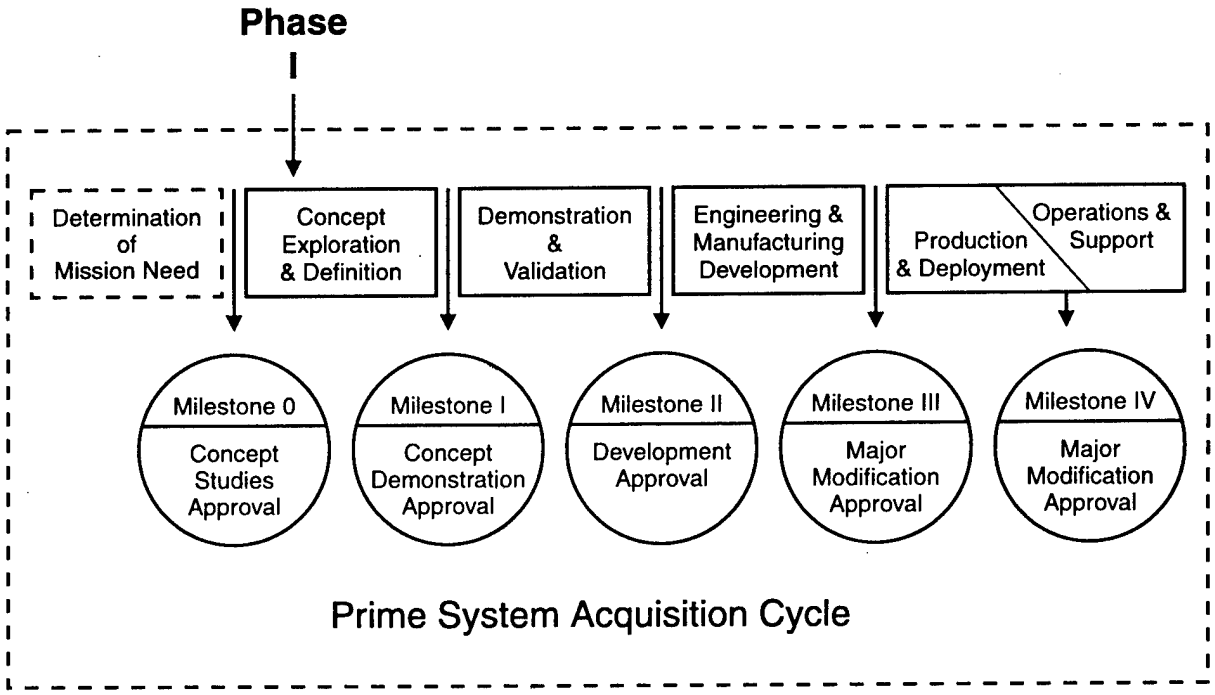
"x is excluded" or "exclude x"—training approach or medium x is not suited for the training situation described.

Balloons may also contain other types of recommendations. Recommendations to revise the training requirements, or to increase certain types of support, may result if requirements cannot be met or if adequate support is not provided for any of the training alternatives. In order to revise the training requirements, it may be necessary or desirable to change the design of the prime system so that the soldier is required to perform fewer tasks, simpler tasks, or tasks that are

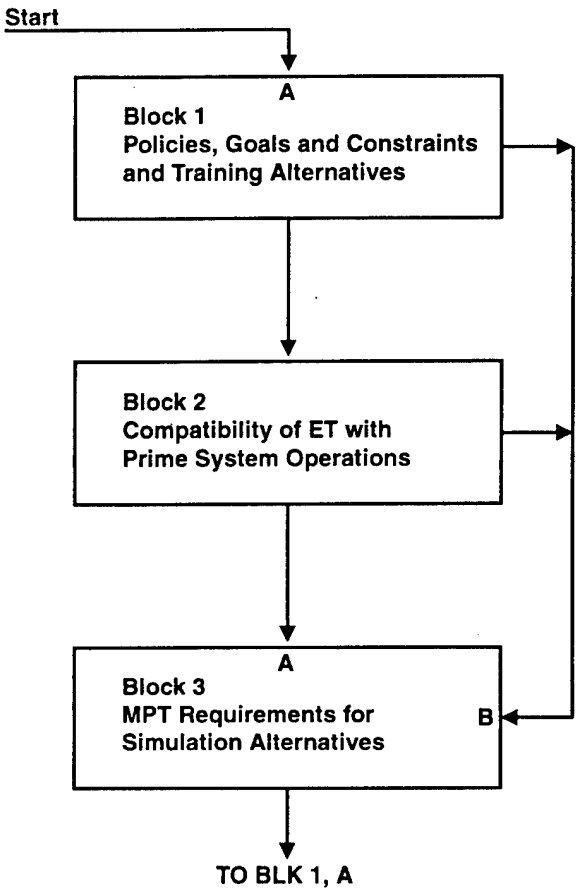
easier to train. Recommendations regarding requirements for the type of maintenance support required are also made.

In addition to recommendations relating to the selection of training alternatives and maintenance of these alternatives, the flowcharts indicate decisions and recommendations that affect the cost of training alternatives. All cost-related factors are marked with an asterisk on the flowcharts. The asterisk appears as a superscript next to the decision or recommendation.

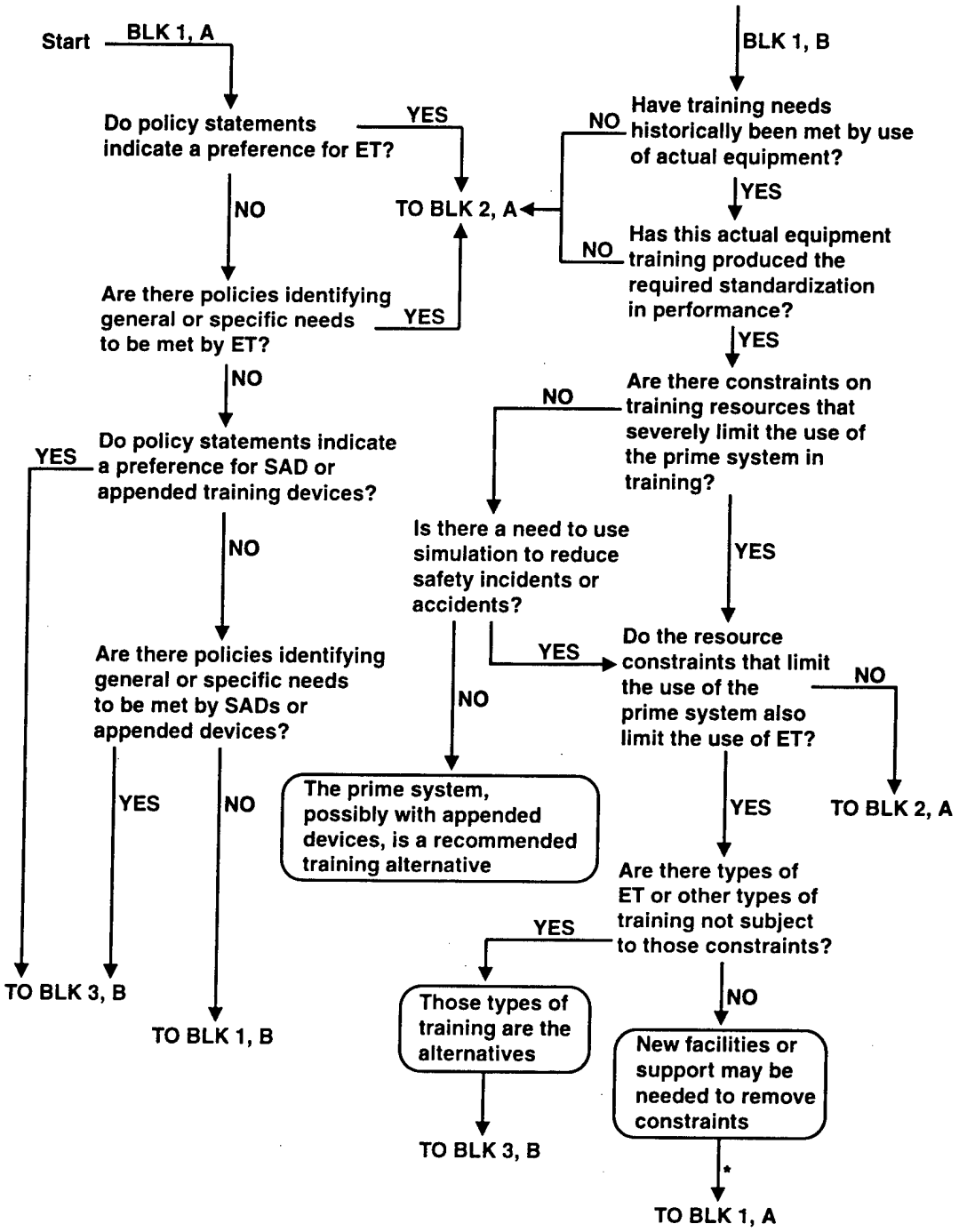
SECTION 4.
ET DECISION AID (PHASE I)



Phase I Flowchart



Phase I, Block 1. Do training policies, goals, or constraints favor simulation alternatives?

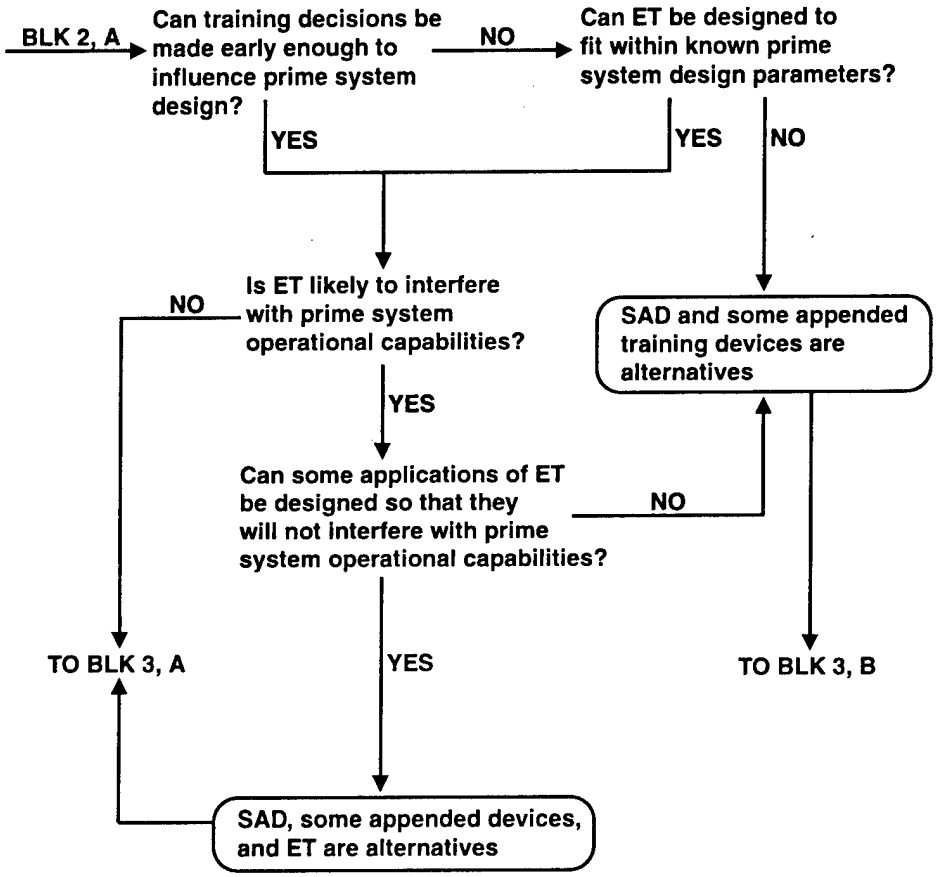


Phase I. Block 1 Help

Purpose: The purpose of this block is to identify the most promising training alternatives as indicated by stated policies and goals which direct the acquisition, subject to the constraints under which the training system must operate.

Rationale: If policy statements and goals indicate a clear preference for ET, or identify general or specific needs to be met by ET, ET is immediately considered further in Block 2. If not and policy indicates either a preference for Stand-Alone Devices (SAD) or appended training, or general or specific needs to be met by SADs or appended training, those alternatives are immediately considered further in Block 3. If no preference for either ET or devices is stated, the next alternative considered is the use of the actual equipment for conducting the required training. However, if the use of the actual equipment for training historically has not produced the desired degree of standardization in performance, then embedded training on the prime system is probably the best way to accomplish that goal, and that option is immediately considered in Block 2. The various types of ET and SAD are assumed to provide, in general, more effective standardization that the use of the actual equipment for training. If using the actual equipment for training historically has produced the required degree of standardization in performance, then the actual equipment is the preferred training alternative, subject to the following two conditions: (1) it is not overly constrained by training resource availability, and (2) it is not more hazardous than other effective training media. If these conditions cannot be met, then resource constraints which would limit the use of ET are considered. If there are none, ET is considered further in Block 2. If there are constraints, other alternatives not subject to those constraints are considered further in Block 3. If there are no types of training which can be conducted under those constraints, then the rationale for the constraints must be examined, revised, and the process restarted at point 1A.

Phase I, Block 2.
Can ET be integrated into the prime system without interfering with system operational capabilities?

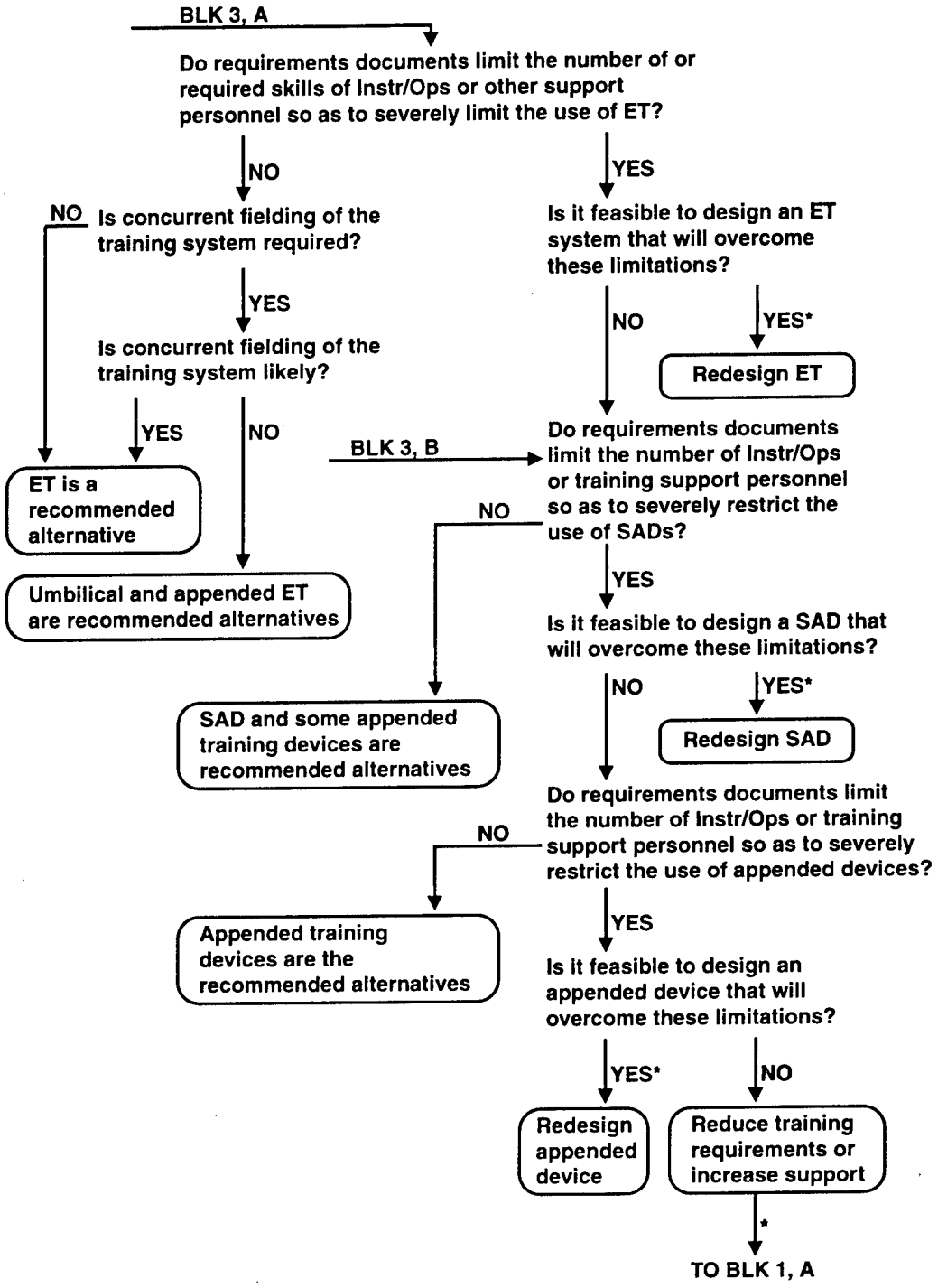


Phase I. Block 2 Help

Purpose: The purpose of this block is to determine is the prime system design can accommodate an embedded training system without unacceptable interference with prime system operational capabilities.

Rationale: One of the first considerations for determining the feasibility of embedded training is the stage of the prime system in the design process. If the necessary information will be available for making embedded training decisions before the prime system design decisions have been finalized, then embedded training may be a viable alternative. When ET decisions cannot be made early in prime system development, it is necessary to evaluate the feasibility of retrofitting an embedded training system for the prime system. If embedded training is feasible considering the known parameters of the prime system design, it is then necessary to evaluate whether it might interfere unacceptably with the operation of the prime system. The exact nature of this interference might lead the analyst to propose different types of embedded training that would not interfere with prime system operations. If embedded training cannot be designed so that it can be accommodated on the prime system without interfering with prime system operation, then SAD and appended devices remain the most reasonable training alternatives.

Phase I, Block 3.
Do MPT requirements limit the simulation alternatives?

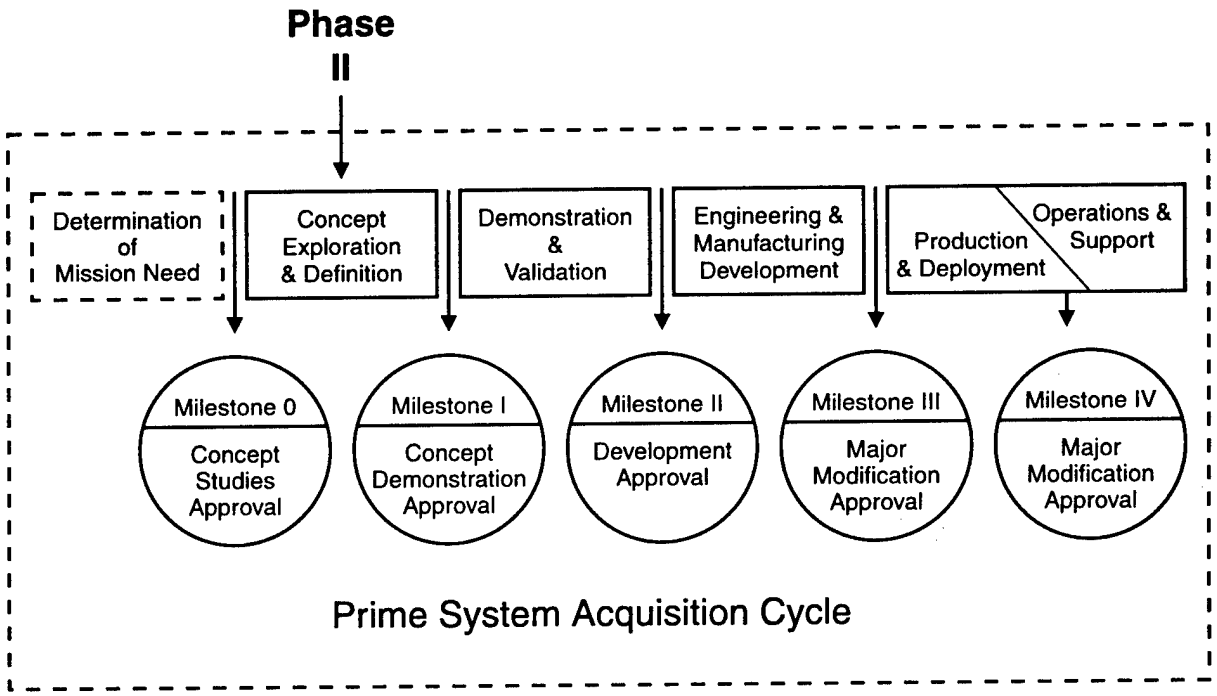


Phase I. Block 3 Help

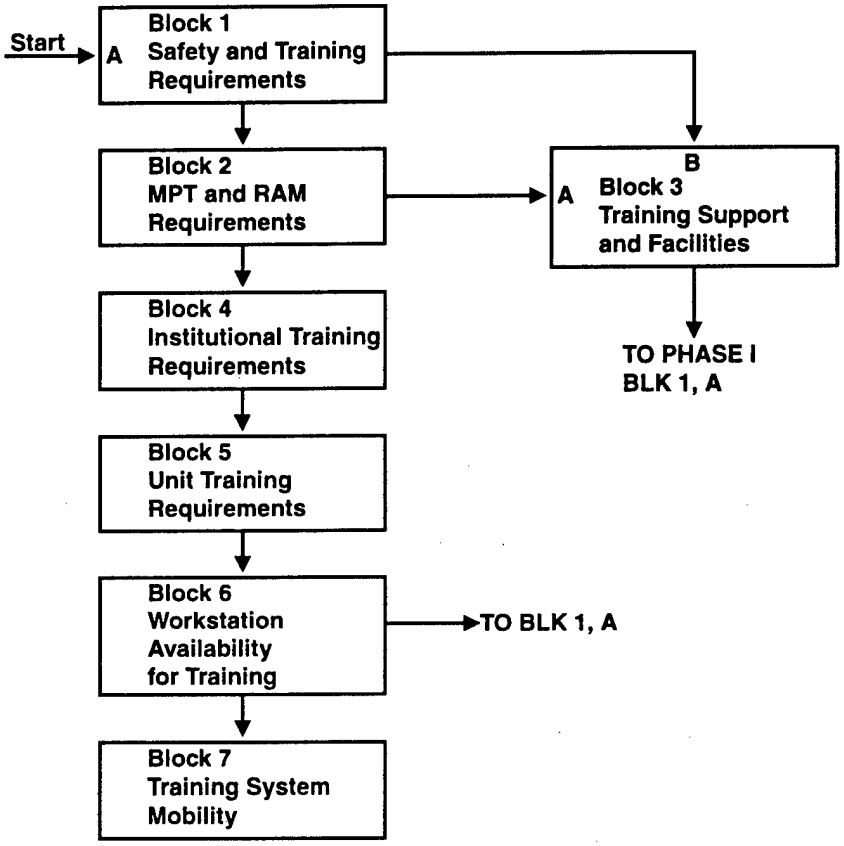
Purpose: The purpose of this block is to determine the extent to which Manpower, Personnel, and Training (MPT) considerations limit the use of embedded training or other simulation alternatives. Training support personnel may be needed to operate or maintain devices or required facilities (e.g., ranges). Requirements documents may place limits on the number and required skills of personnel available to support the training system. Further restrictions on training may derive from the requirement to field the training system concurrently with the prime system. Limits on the required skills include limits on the training of Instructor/Operators or other support personnel.

Rationale: If requirements documents severely limit the applicability of embedded training, then the analyst must decide if types of embedded training can be designed that will meet the stated requirements. For example, adding automated instructional features or designing the system so that a single Instructor/Operator can operate several training systems may allow the requirements to be met. If not, then are there SADs or appended devices that can meet these requirements? The types of embedded training, SADs, or appended devices that can meet the requirements are recommended. If none of the training alternatives can meet MPT requirements, then the training support requirements must be reduced so that less MPT support is needed or the constraints must be relaxed to allow for the provision of additional support. One way to reduce the support requirements is to redesign the prime system so that less training is required. Either change will require a re-analysis of the training alternatives in Block 1. If MPT requirements do not adversely affect the applicability of ET, then the need for concurrent fielding of the training system is used to choose among the various types of embedded training. If concurrent fielding of the prime system and the embedded training system is required but unlikely, types of ET systems for which some training components can be developed separately from the prime system, such as umbilical or appended ET, are recommended.

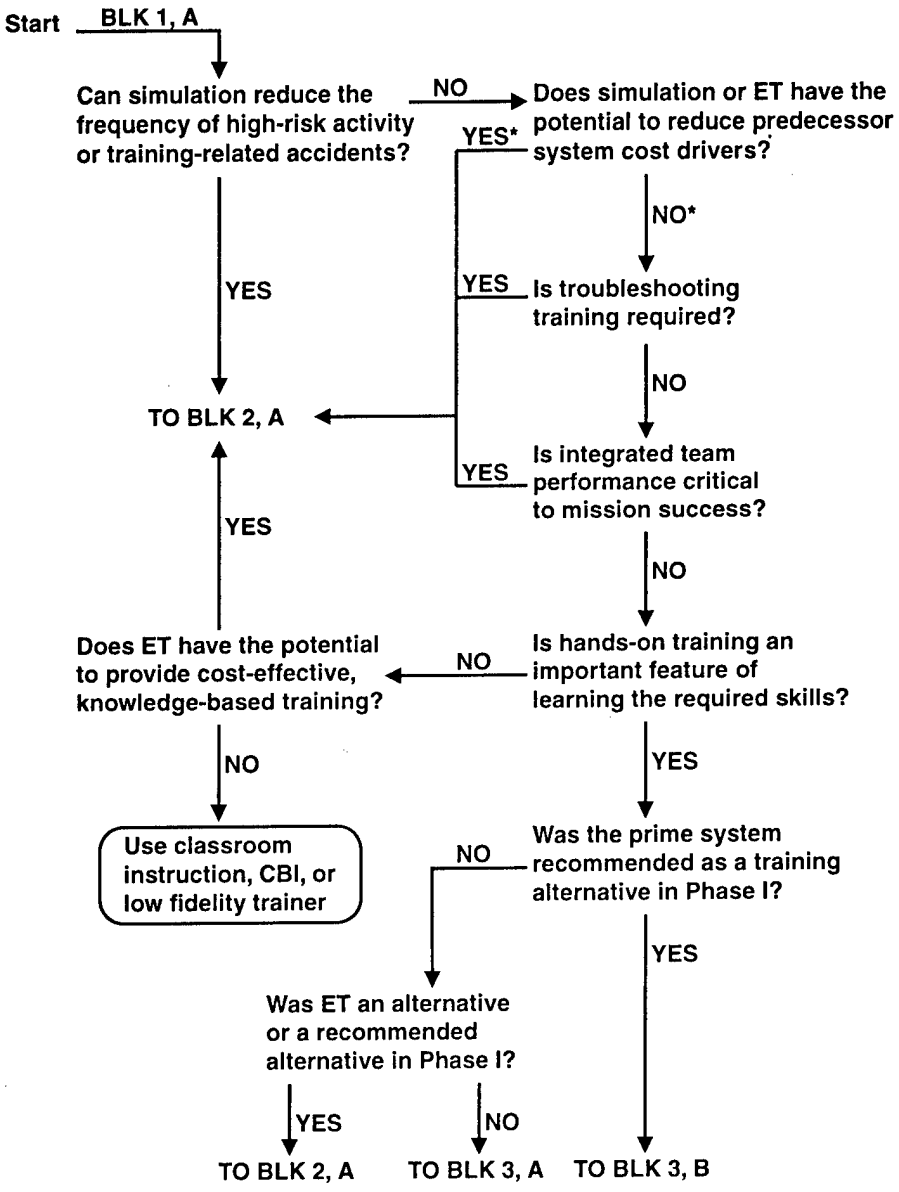
SECTION 5.
ET DECISION AID (PHASE II)



Phase II Flowchart



Phase II, Block 1.
Do safety and training requirements suggest ET or other simulation alternatives?



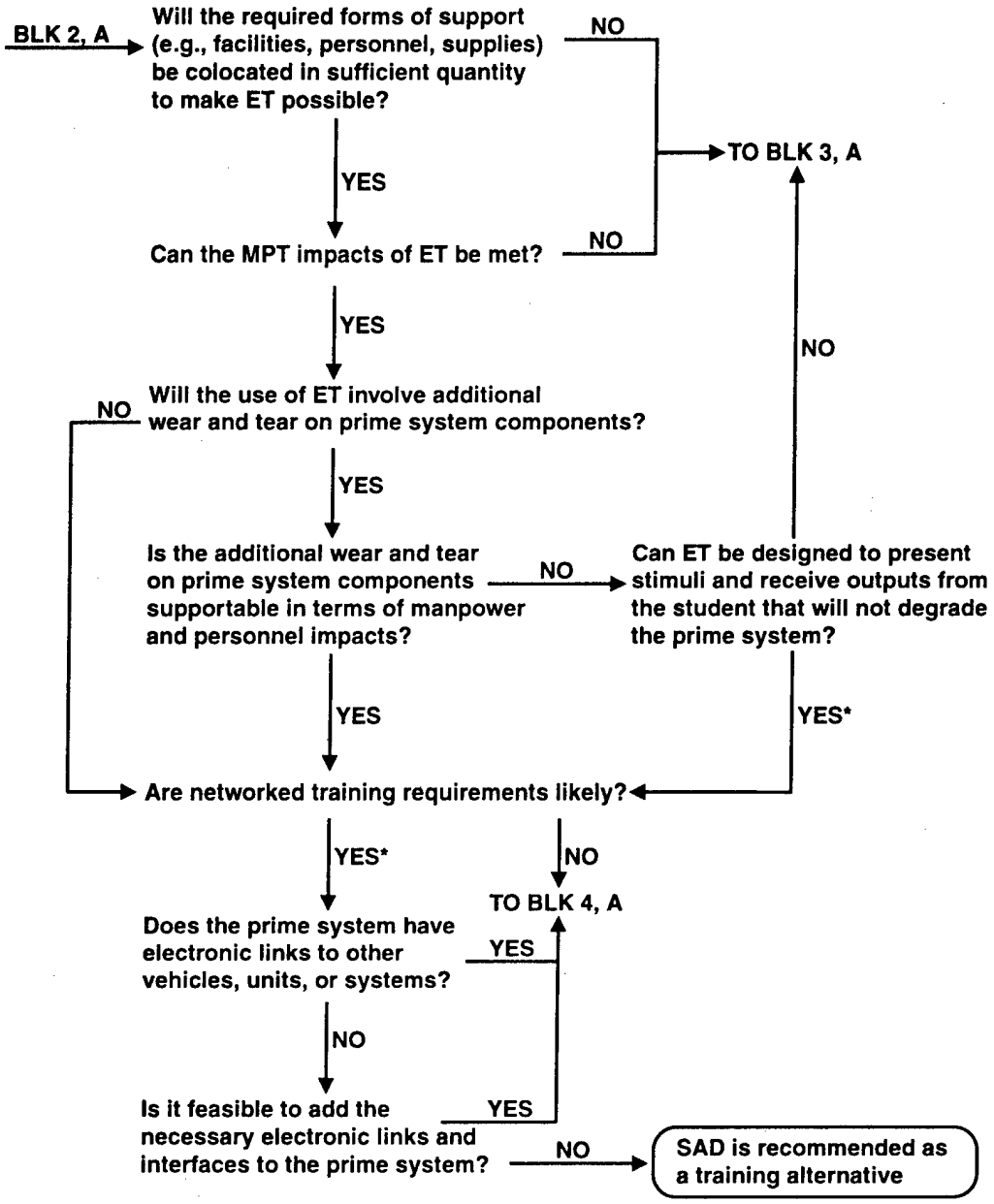
Phase II. Block 1 Help

Purpose: The purpose of this block is to identify the training alternatives that best satisfy safety and special training requirements.

Rationale: Depending on the hazards associated with the use of the prime system and the nature of the system simulator, simulation can reduce training risks. If simulation can reduce the frequency of high-risk activity or training-related safety incidents or accidents, then ET and other simulation alternatives are considered further in Block 2. If simulation cannot improve safety, then the potential for simulation or ET to reduce costs or fulfill special training requirements is explored. If simulation or ET can reduce costs, or if troubleshooting or integrated team performance is a requirement, then ET and simulation alternatives are considered further in Block 2.

Otherwise, the importance of hands-on training is assessed. If hands-on training is a minor consideration, then the potential of ET to provide cost-effective, knowledge-based instruction is considered. If such potential exists, ET is considered further in Block 2. If it does not, classroom instruction, computer-based instruction (CBI), or a low fidelity trainer will probably fulfill the training requirements. If hands-on training is critical to learning and the use of the prime system for training was recommended in Phase I, then the use of the prime system for training is considered further in Block 3. If hands-on training is important and the prime system was not recommended as a training alternative in Phase I, but ET was an alternative or a recommended alternative in Phase I, then ET is considered further in Block 2. If neither ET nor the prime system were recommended in Phase I, then other simulation alternatives are considered in Block 3.

Phase II, Block 2.
Can the prime system support ET, given MPT and RAM requirements?

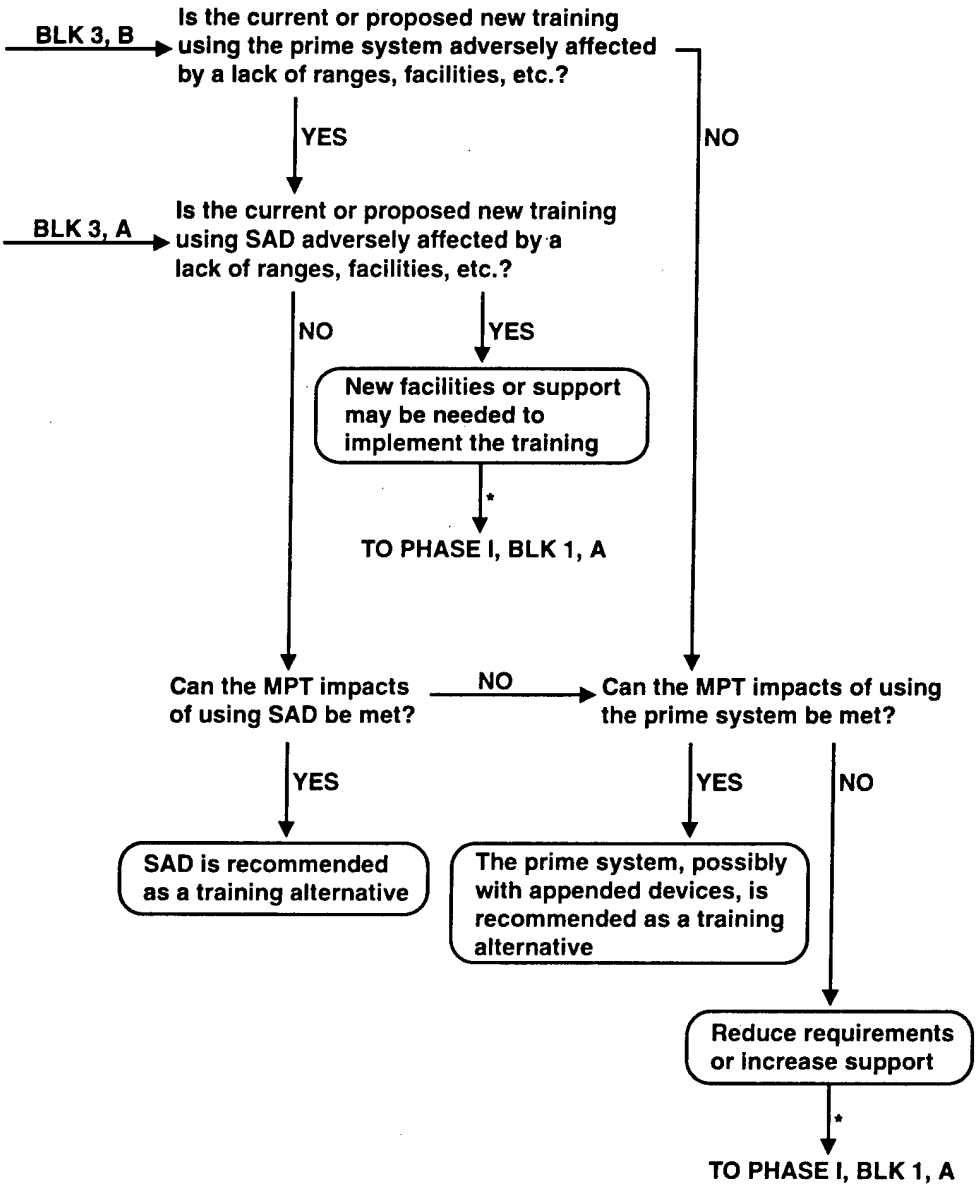


Phase II. Block 2 Help

Purpose: The purpose of this block is to evaluate the capability of the prime system to support ET, considering the impacts of ET on Manpower, Personnel, and Training (MPT) and on system Reliability, Availability, and Maintainability (RAM).

Rationale: The effective utilization of a training system depends on bringing together the resources needed to train at the appropriate time and place. Adequate numbers of skilled personnel to conduct the training, compatible facilities, and the necessary supplies must be present to properly utilize the embedded training system. Without information to the contrary, it can be assumed that the required support for conducting embedded training will be provided. However, note that organizational factors and funding may limit the types of support that can be provided. If the necessary support for ET is unavailable, then questions in Block 3 are asked to determine if alternative forms of training can be supported. If ET appears to be supportable, then the impact of the additional wear and tear on the prime system is examined. If this impact results in an unacceptable maintenance load, then the possibility that ET can be designed so that it does not adversely impact the prime system is explored. If ET cannot be designed to eliminate the adverse impacts of embedded training on the prime system, the questions in Block 3 are asked to determine if other simulation alternatives are supportable. If ET can be designed so that it does not unduly stress the prime system or the impact can be supported, then it is determined whether the prime system can support networked embedded training requirements. Networked training requirements will be likely if either of two task conditions are met: (1) the task is a collective task that requires coordination between elements; or (2) the task is an individual or crew task which changes in terms of skill demands when performed in conjunction with other elements in a simulated combat environment. If networked training requirements are likely but cannot be supported by ET because it is not feasible to provide the necessary electronic interfaces, then these requirements must be met by networked stand-alone devices. If prime system characteristics can support networked training, or if networking is not required, then ET is considered further in Block 4.

Phase II, Block 3. Are other training alternatives supportable in terms of MPT and training facility requirements?

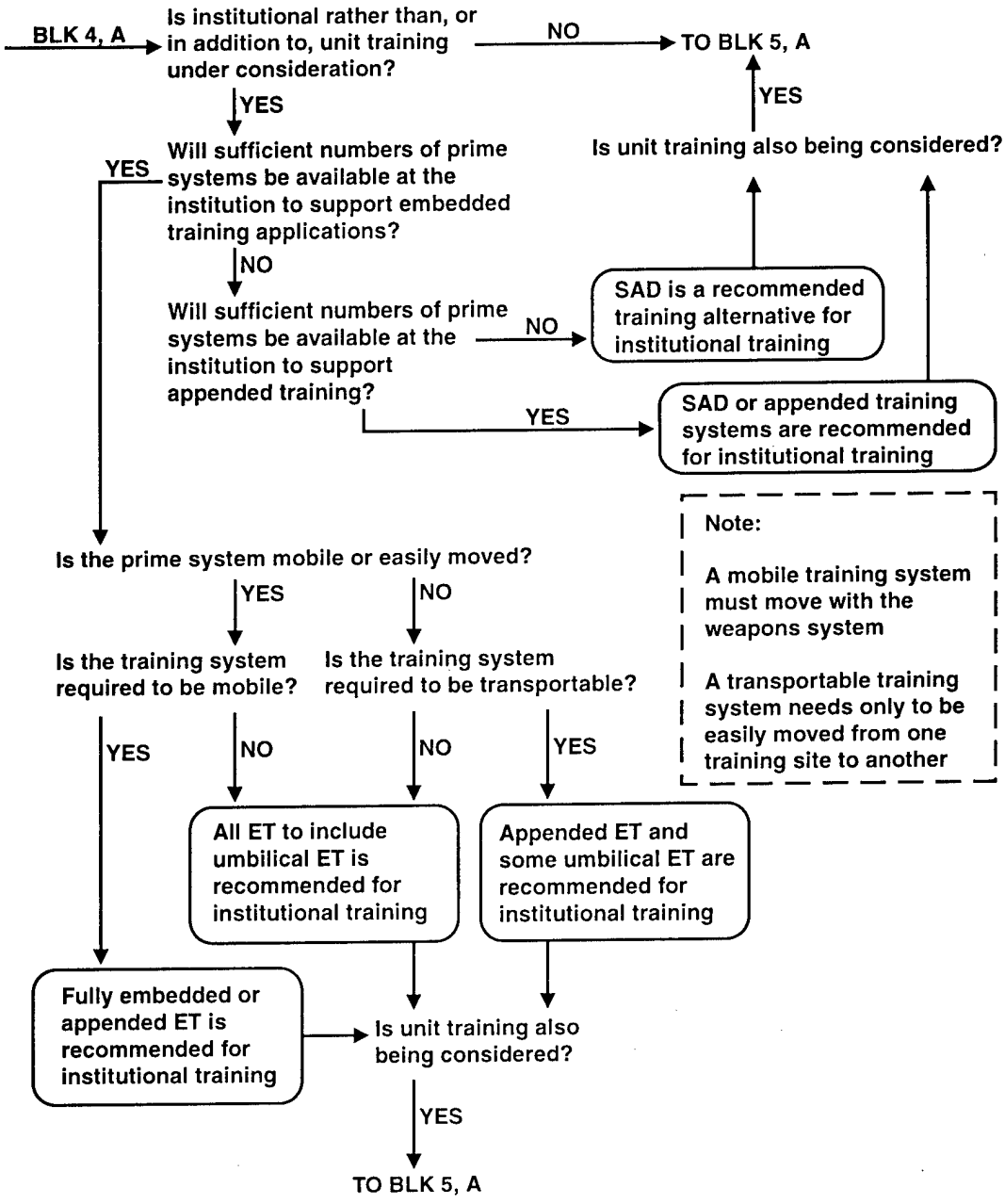


Phase II. Block 3 Help

Purpose: The purpose of this block is to determine the supportability of other training alternatives to embedded training. Adequacy of facilities and personnel to support these training alternatives is assessed. The questions in this block are considered only when embedded training is not advisable or supportable.

Rationale: When embedded training cannot be supported, it may still be possible to train using the prime system or training devices. The necessary ranges, facilities, and personnel must be available over the life cycle of the prime system to use the prime system or a training device to train. If it appears that these training alternatives can be adequately supported, then they are recommended. However, note that organizational factors and funding may limit the types of support than can be provided. If neither stand-alone devices nor the prime system can be supported, then either new facilities or support may be needed. The support might consist of additional instructional or maintenance staff or additional targets for use on the ranges. If support cannot be increased, then training requirements must be reduced. One way of reducing training requirements is to design the prime system so that less training is required to operate or maintain it. Requirements for additional instructional support for devices can be reduced by automating many of the instructional functions, and requirements for maintenance support can be reduced by making the prime system more reliable or easier to maintain. Changing the support provided or the requirements necessitates a reevaluation of training system alternatives in Phase I.

Phase II, Block 4. Which types of ET or simulation alternatives meet institutional training requirements?



Phase II. Block 4 Help

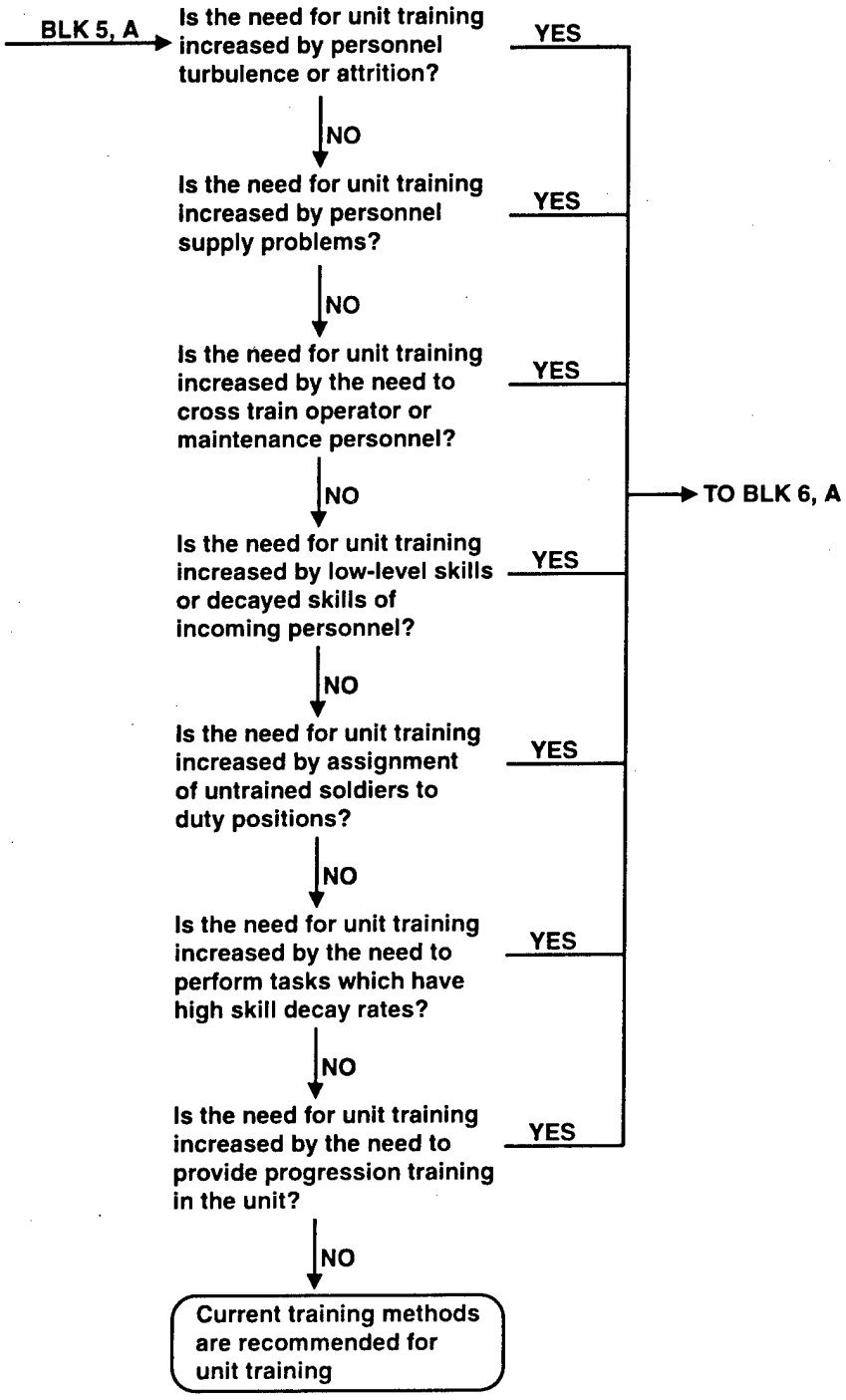
Purpose: The purpose of this block is to differentiate among the various types of embedded training and training devices based on their capabilities to satisfy institutional training requirements during both peacetime and mobilization.

Rationale: If institutional training is being considered, the availability of a sufficient quantity of prime systems to support embedded training at the institution is assessed. If the numbers of prime systems available at the institution cannot support ET, but can support appended training, then either SAD or appended training are the recommended alternatives for institutional training. If the numbers of prime systems available at the institution can support neither ET nor appended training, then SAD is recommended for institutional training. If, on the other hand, a sufficient number of prime systems are available for institutional training, then requirements for training system mobility and transportability are considered.

A mobile training system must by definition move with the prime system. One reason to require the training system to move with the prime system is to use the training system in realistic moving vehicle exercises. Another reason is to make the training readily available to soldiers wherever they take their prime system training. A transportable training system is one that can be moved from one training site to another relatively easily, but must be moved apart from the prime system. As define here, a transportable system should not require extensive preparation for relocation.

If the prime system does not move easily and the training system must be transportable from one training site to another, then only appended ET or umbilical ET are applicable because a fully embedded system must stay with the system to which it is embedded. If the training system need not be moved, then all types of ET to include fully embedded can be used with an immobile prime system. If the prime system can move easily and the training system is required to move with it, fully embedded or appended ET at the best alternatives because they typically reside on the vehicle. If the prime system can move easily, but there is no requirement for the training system to move with it, then all three types of embedded training are options for meeting the institutional training requirements. After determining the best options for meeting institutional requirements, the analyst may want to consider unit training requirements in Block 5.

Phase II, Block 5.
Do unit training requirements suggest ET or other simulation alternatives?

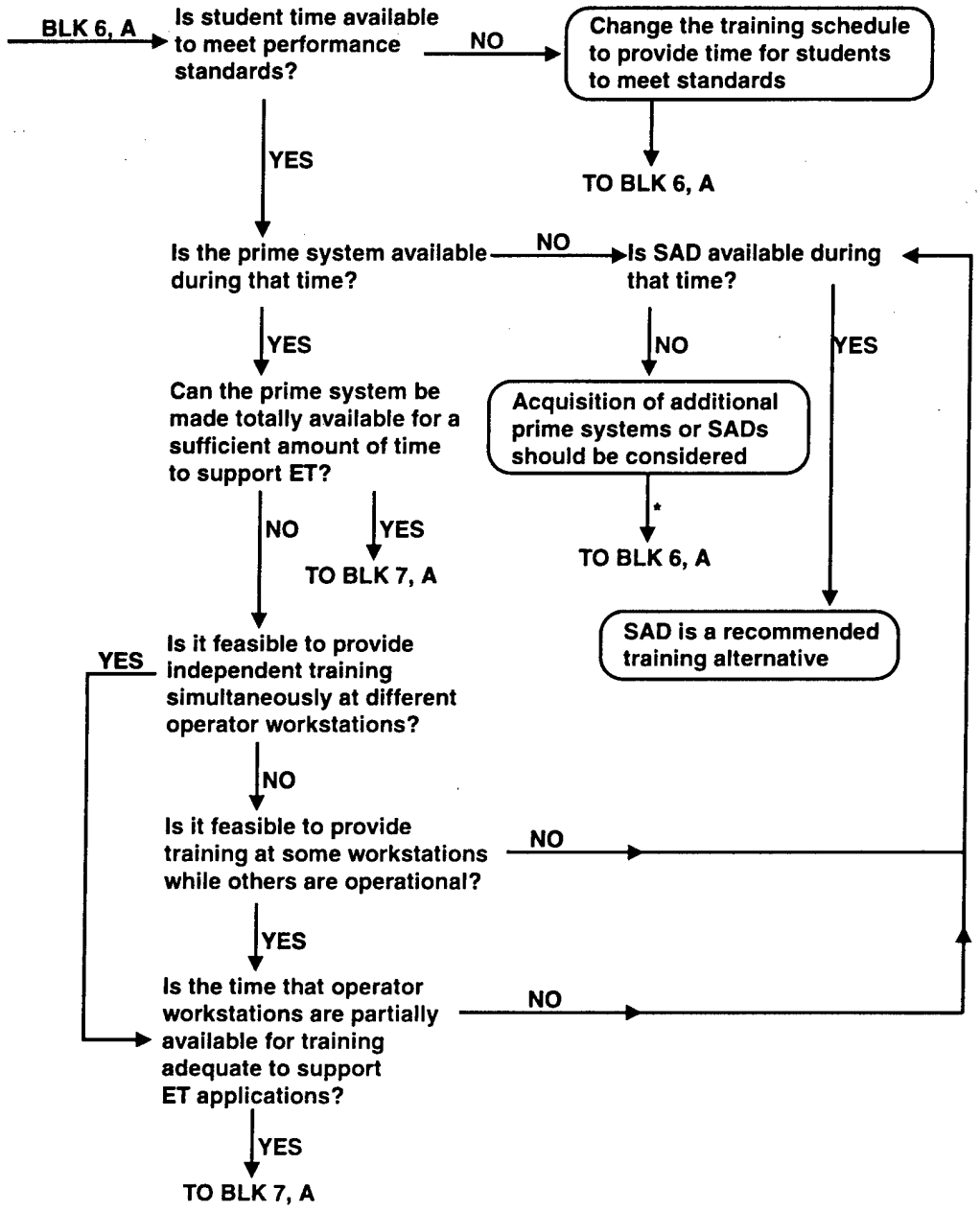


Phase II. Block 5 Help

Purpose: The purpose of this block is to determine the need for additional training in the unit.

Rationale: This block considers factors that increase the need for training in the unit. The presence of these factors suggests that additional training capabilities (e.g., embedded training) may be required; ET will then be considered in Block 6. Factors that may increase the need for additional unit training include personnel turbulence, poor skills of incoming personnel, rapid decay of skills, the need to cross train soldiers in more than one duty position, and the need for soldiers to progress to duty positions requiring higher levels of performance (progression training) to replace attrited personnel. If none of these factors are present, then current training approaches may be adequate.

Phase II, Block 6.
Will the prime systems or their individual workstations be available for a sufficient amount of time to support ET?



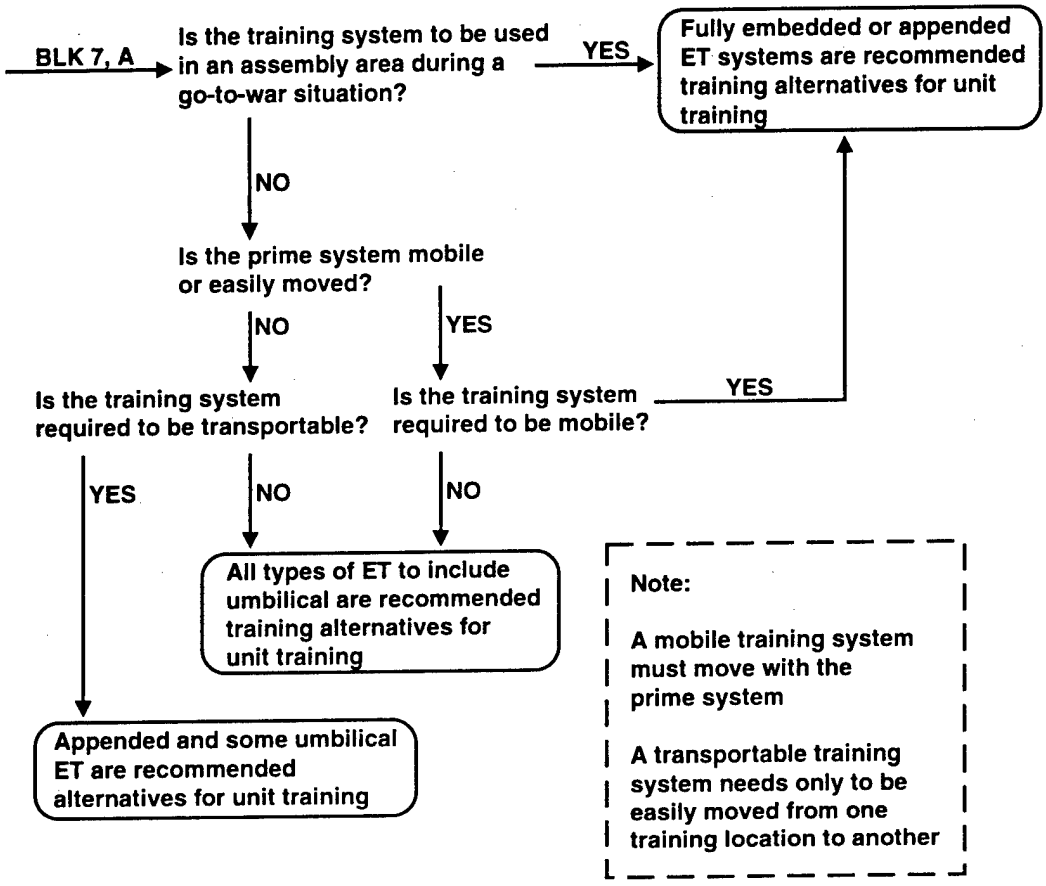
Phase II. Block 6 Help

Purpose: The purpose of this block is to determine the availability of the prime system for conducting embedded training during peacetime and mobilization.

Rationale: The use of the prime system for its combat role, in combination with required downtime for maintenance, may not leave it available for enough time to serve in a unit training role. In such cases ET may not be the preferred alternative for unit training. After establishing that the soldiers have enough time available to be trained to performance standards, the availability of the prime system for training during that time is determined. Prime system availability will be high if the embedded training system is on-line so that normal system operations are unaffected. If the prime system is not available during that time, then the availability of stand-alone devices is determined. If the proposed number of SADs does not provide adequate availability for all students to meet performance standards, then more SADs or more prime systems must be acquired to accomplish the required training. The acquisition of additional systems makes it necessary to return to Block 6, A and reevaluate the applicability of embedded training. If the lack of student time prevents soldiers from meeting standards, then unit training schedules must be adjusted and the analysis continues.

If the prime system is available for training, then the extent of this availability is determined. If the prime system can be made totally available for an adequate amount of time, then the applicability of ET is evaluated further in Block 7. Otherwise, whether it is feasible to design the ET system so that it supports independent training simultaneously at different operator workstations or so that one workstation is operational while the other is being used for training is determined. If so, and if the time that the worstations are partially available is adequate to support ET applications, then ET is considered further in Block 7. If not, then the availability of SAD for the time required to meet training standards is determined. If SADs are available for providing the required training, then SADs are recommended.

Phase II, Block 7. Which types of embedded training meet unit training requirements?



Phase II. Block 7 Help

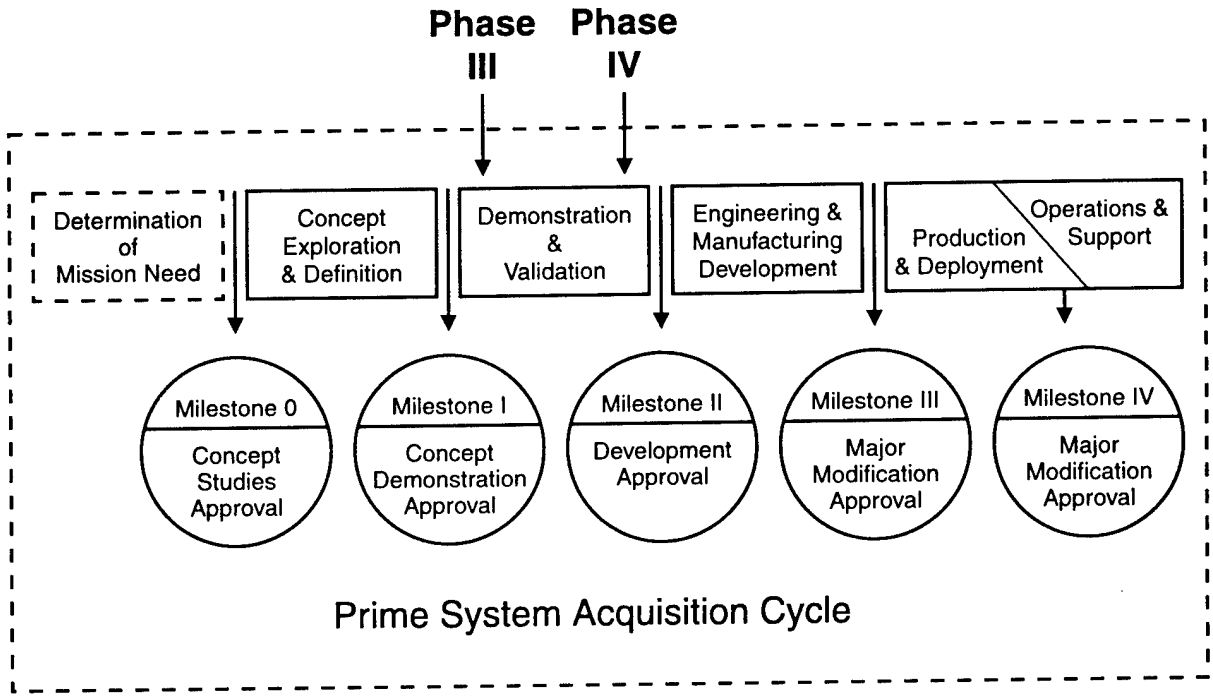
Purpose: The purpose of this block is to differentiate among the various types of embedded training based on their capabilities to satisfy unit training requirements.

Rationale: Because embedded training utilizes the prime system for training, the most likely training site is where the prime system is located. If the prime system is fixed at a particular site, then that is where the training must occur. If the prime system is mobile or transportable, then training may be conducted at one of several sites.

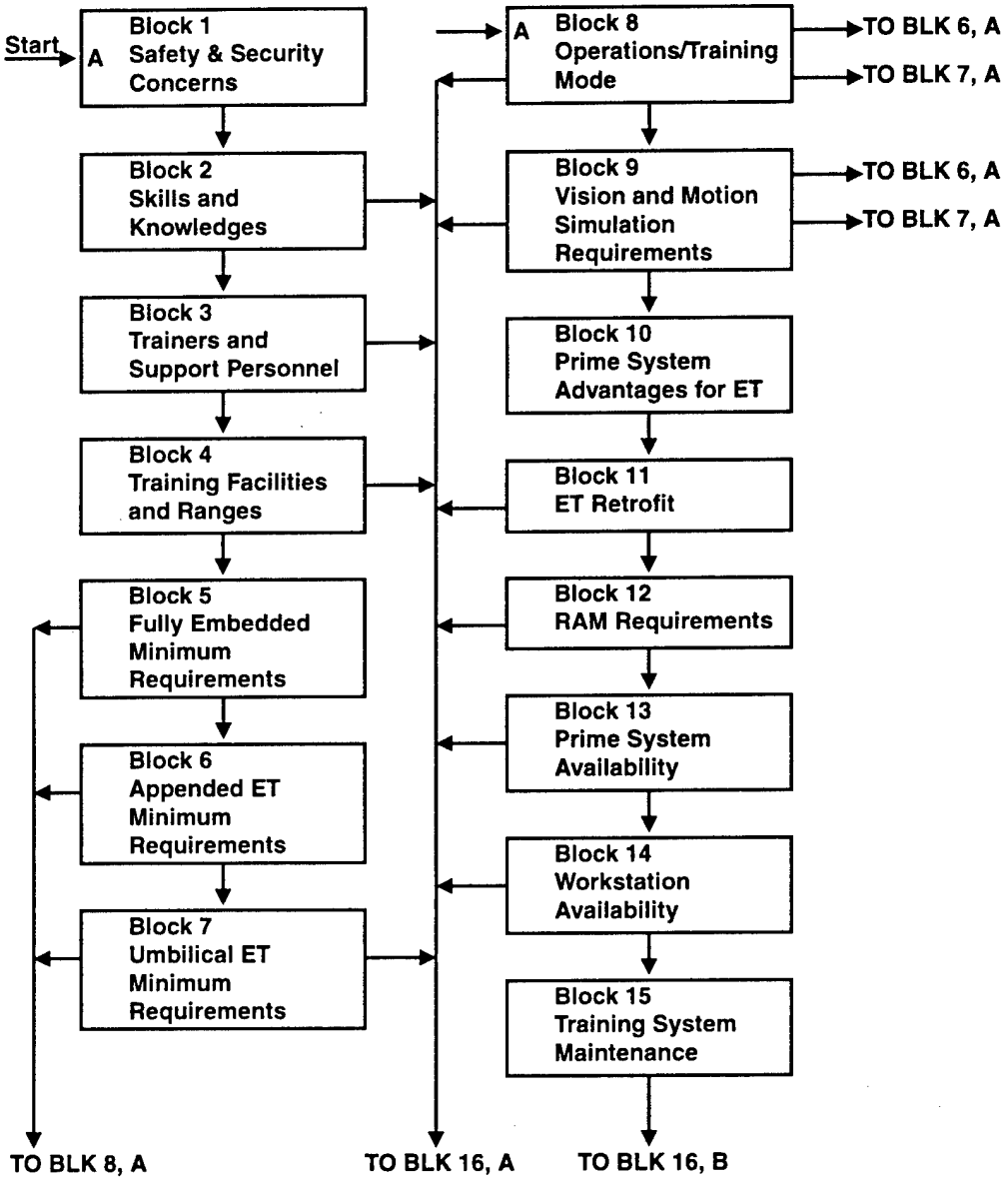
A mobile training system must by definition move with the prime system. One reason to require the training system to move with the prime system is because it is used in realistic moving vehicle exercises. Another reason is because the training is readily available to soldiers wherever they take the prime system. A transportable training system is one that can be moved from one training site to another relatively easily, but must be move apart from the prime system. As defined here a transportable system should not require extensive preparation for relocation.

If the training system is to be used in an assembly area during a go-to-war situation, then the clear training choices are fully embedded or appended ET systems. Most umbilical ET systems would be too bulky to easily transport to an assembly area and adequate power to run these training systems would probably not be available. Similarly, stand-alone devices would be ruled out for the same reasons. If a training system will not be used in an assembly area, then the analyst must determine whether the prime system that it supports is mobile. If the prime system can move easily, and the training system must be transportable from one training site to another, then only appended ET or umbilical ET are applicable because a fully embedded system must stay with the system in which it is embedded. If the training system need not move, then all types of ET, to include fully embedded, can be used with an immovable prime system. If the prime system can move easily and the training system is required to move with it, fully embedded or appended ET are the best alternatives because they typically reside with the prime system. If the prime system can move easily but there is no requirement for the training system to move with it, then all three types of embedded training are options.

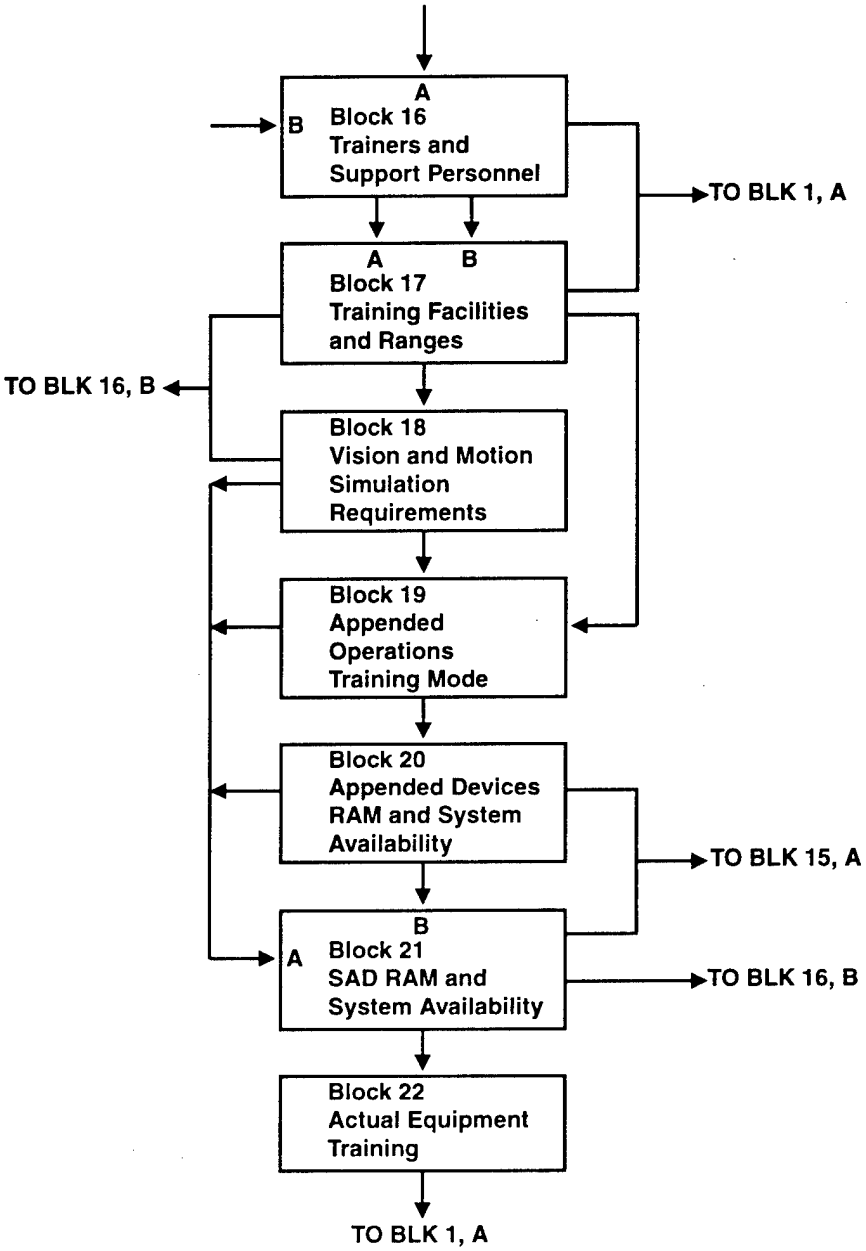
SECTION 6.
ET DECISION AID (PHASE III/IV)



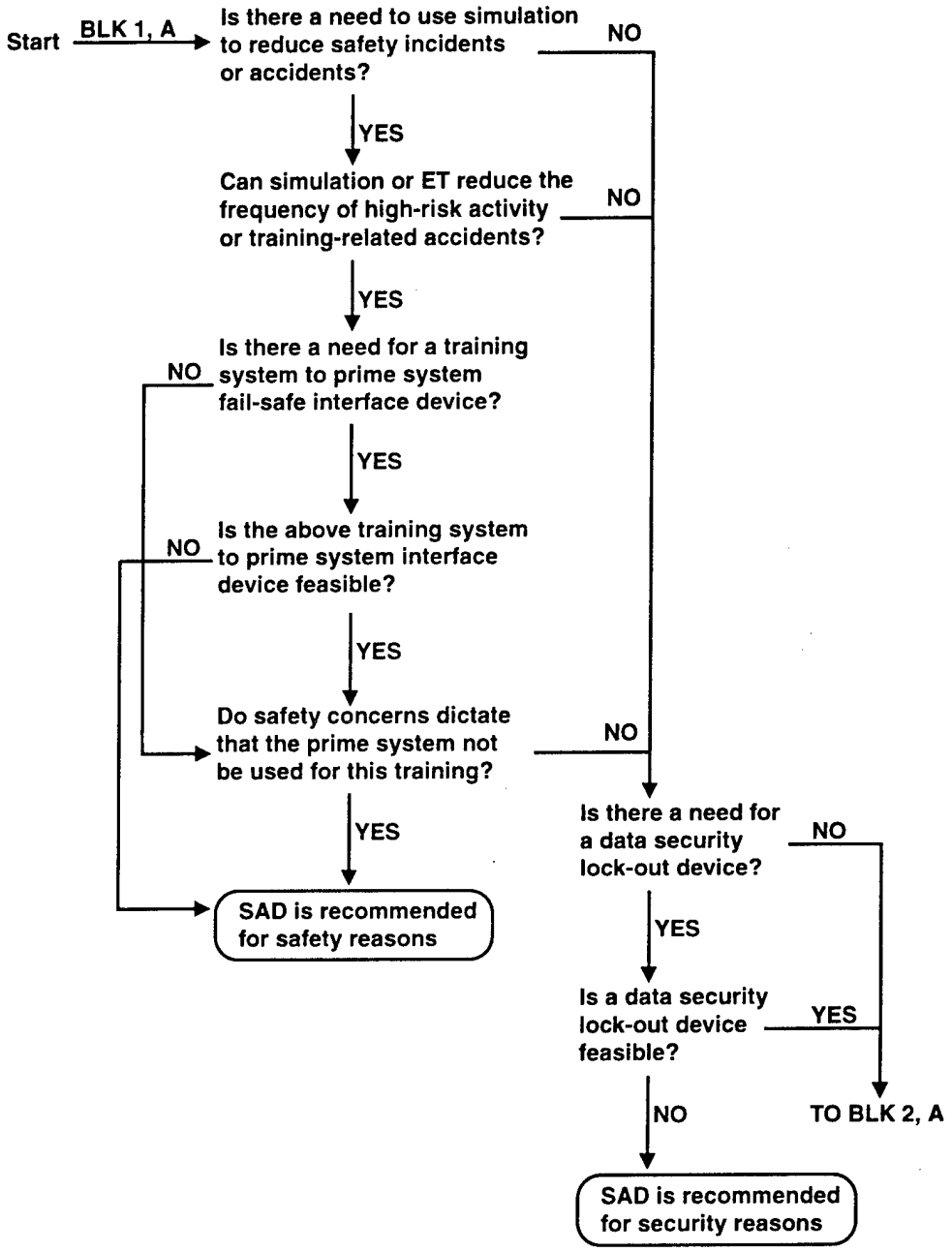
Phase III/IV Flowchart



Phase III/IV Flowchart



Phase III, Block 1.
Do safety or security concerns preclude use of the prime system in training?



Phase III. Block 1 Help

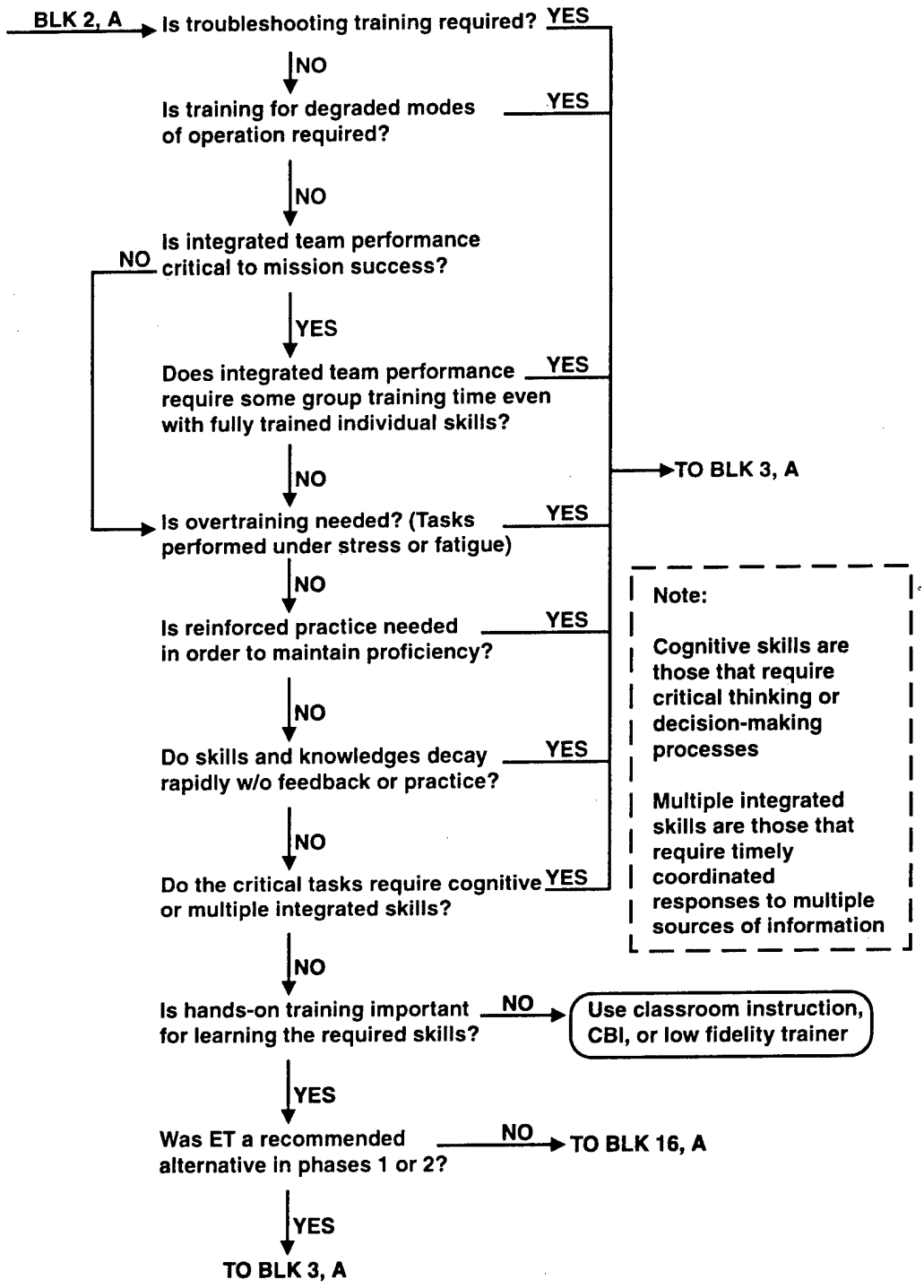
Purpose: The purpose of this block is to determine if safety or security considerations preclude the use of the prime system in conducting training and the extent to which various simulation alternatives have the potential to reduce accidents.

Rationale: Experience with the prime system or with comparable systems should yield estimates of the frequency and severity of safety-related accidents or incidents. If the potential for training-related accidents is great using the prime system, there may be a need to consider simulation alternatives for meeting training needs while reducing accidents. Depending on the type of simulation being considered and the physical characteristics of the training hardware, the use of training devices or simulations may or may not reduce the frequency of high-risk activity. For example, an appended training system on a heavy, rapidly moving vehicle may still present considerable risk in training exercises, while a stand-alone device may decrease these risks considerably. An embedded training system may or may not decrease risks, depending on how it is configured and whether its use involves actual vehicle movement.

If there is a need to reduce training accidents and simulation can result in training safety increases, then either devices or ET are the training options. Because ET depends on the use of the prime system, it is essential that embedded training systems include a fail-safe interface device to prevent accidental weapon or laser firing during the training sessions. If the fail-safe interface device is not feasible or some other safety hazard dictates that the prime system should not be used in training, then a stand-alone device is recommended for safety reasons. If the fail-safe interface is feasible and use of the prime system does not otherwise significantly increase safety hazards, then security risks associated with the use of ET are considered. Similarly, if the need to reduce accidents or the potential of simulation to accomplish such reduction is small, then data security risks are considered.

Data security may be placed at risk when classified or sensitive data or information used in prime system operations is accessible in the training mode. Special lock-out features may need to be included in embedded training systems to prevent unauthorized disclosure of this information. If data security is not a problem or if a data lock-out mechanism is feasible, then embedded training and other training system alternatives are considered further in Block 2. If data security lock-out features are needed, but are not feasible, then SAD is recommended as an alternative to training systems that interact with the prime system.

Phase III, Block 2. Do the skills and knowledges to be taught suggest ET?



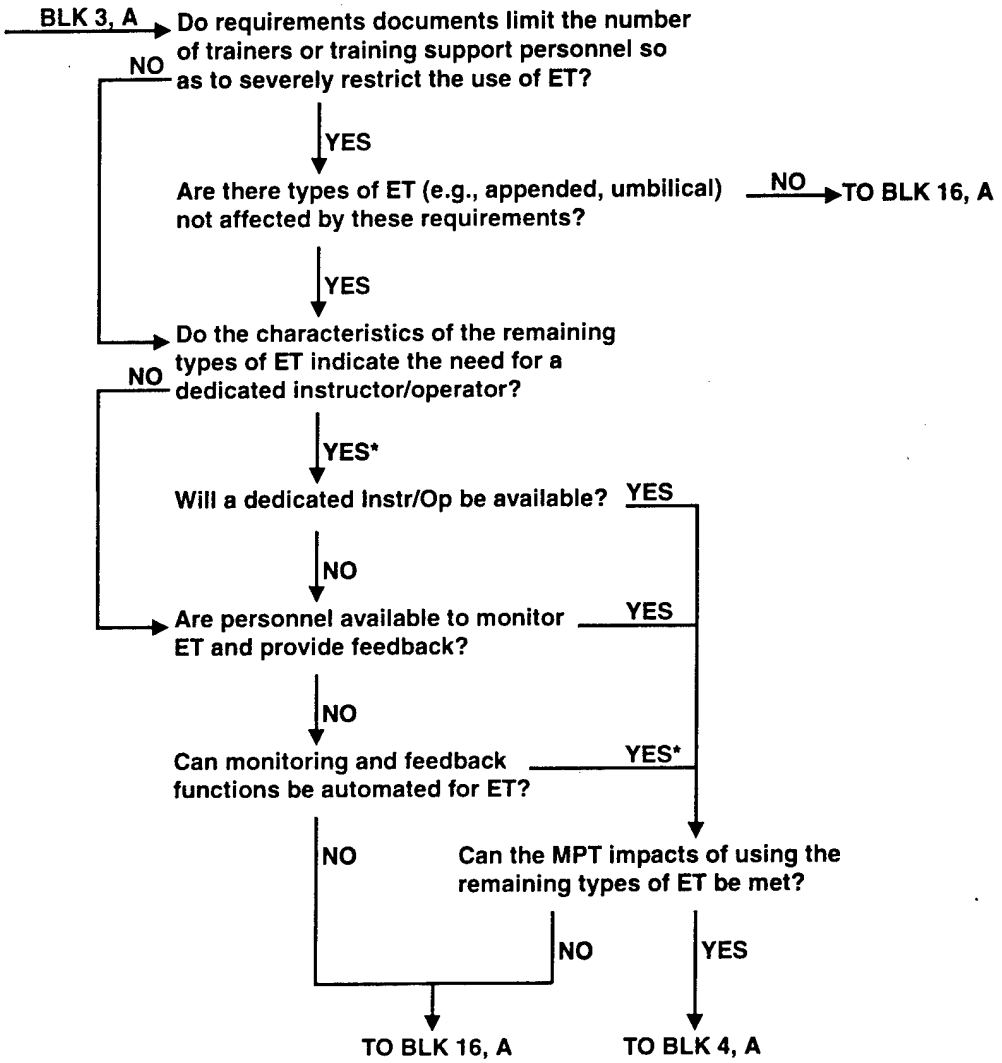
Phase III. Block 2 Help

Purpose: The purpose of this block is to determine if the kind and amount of training required suggests the need for embedded training or other simulation alternatives to increase training effectiveness.

Rationale: Embedded training and other simulation alternatives may include design features to simulate system faults for training troubleshooting skills and degraded mode conditions for training degraded mode operations. In addition, these training systems will include built-in stimuli and feedback mechanisms for providing the reinforced practice necessary for maintaining most skilled performances. Because these training systems are generally less costly to operate than the prime system, more training can be conducted within budget constraints. Skills that are performed under conditions of stress or fatigue and other skills requiring overtraining, skills that decay rapidly, and skills that require frequent reinforced practice may be maintained at higher levels using embedded training or other simulation training alternatives. Frequent reinforced practice can also help to fine-tune skills when integrated team performance, cognitive skills, or multiple integrated skills are critical to mission success. Cognitive skills are those that require critical thinking or decision-making processes rather than those that require routine operating procedures. Multiple integrated skills are those that require timely coordinated responses to multiple sources of stimuli or information; these skills require near simultaneous rule-based performance.

If the types of skills and knowledges to be taught suggest ET or other simulation alternatives, these alternatives are considered further in Block 3. If the kinds of skills do not specifically indicate embedded training, embedded training or some other high fidelity simulation may still be needed if hands-on training is important to learning the required skills. If embedded training was recommended either in Phase I or II, then it should be considered first in Block 3; if not, then other training alternatives are considered in Block 16. If hands-on training is not considered to be important for skill acquisition, then classroom instruction, computer-based instruction, or a low fidelity mock-up or trainer should be used.

Phase III, Block 3. Do the numbers of trainers or support personnel allowed by requirements documents limit or preclude ET use?



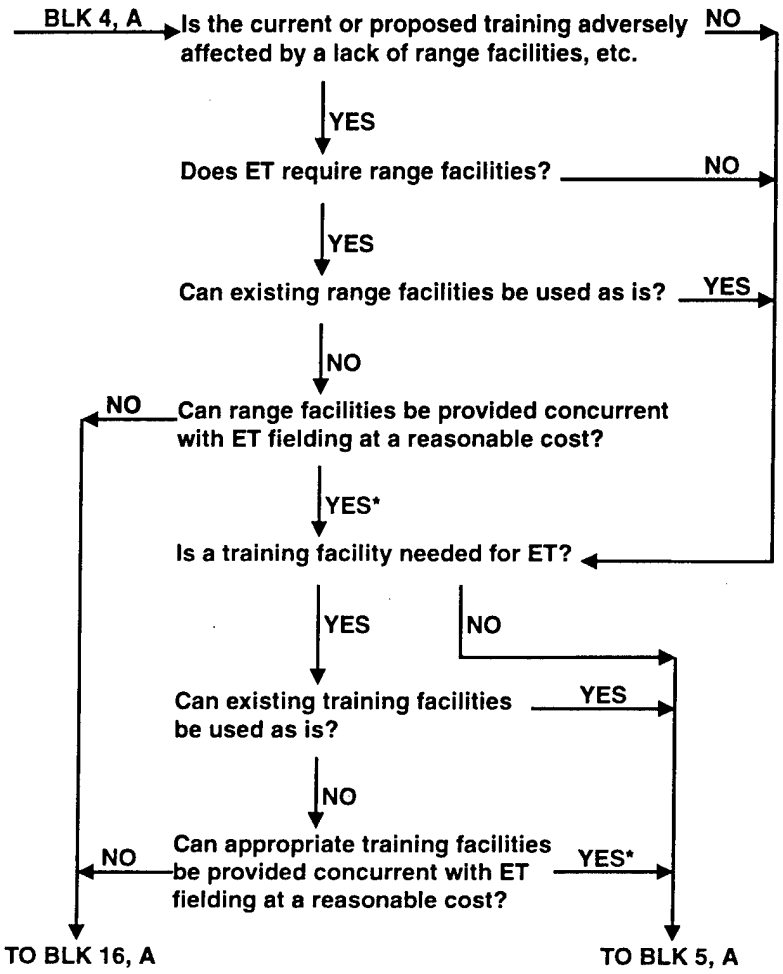
Phase III. Block 3 Help

Purpose: The purpose of this block is to identify factors that may limit or restrict the use of embedded training for meeting training requirements. Requirements documents may restrict the use of embedded training by limiting training support personnel or the number of training systems that are to be fielded.

Rationale: The effectiveness of an embedded training system may be affected by the number of systems fielded and the number and types of personnel available to support the fielded systems. In the unit, personnel are likely to provide training support as an additional duty. Requirements documents, due to costs or other constraints, may fail to allocate a sufficient number of embedded training systems or the personnel required to support them. If this occurs and no types of embedded training can be identified that can meet training requirements given the constraints, then training alternatives, to include SAD and appended devices, are considered in Block 16.

For those embedded training systems not restricted by constraints imposed in requirements documents, a dedicated instructor/operator (Instr/Op) must be available if needed unless other personnel are available to perform the necessary instructional functions, such as monitoring student performance and providing feedback. If personnel are not available to perform these functions, then embedded training may still be an option if performance monitoring and feedback functions can be accomplished by designing an embedded training system with automated instructor features. If no means can be provided to serve instructor functions for embedded training, then other training system alternatives are considered in Block 16. If embedded training can meet all of the specific requirements examined in this block, and it can satisfy other Manpower, Personnel and Training (MPT) requirements, then embedded training is considered further in Block 4. If not, other training system alternatives are considered in Block 16.

Phase III, Block 4.
Will range and training facilities be available to support ET?



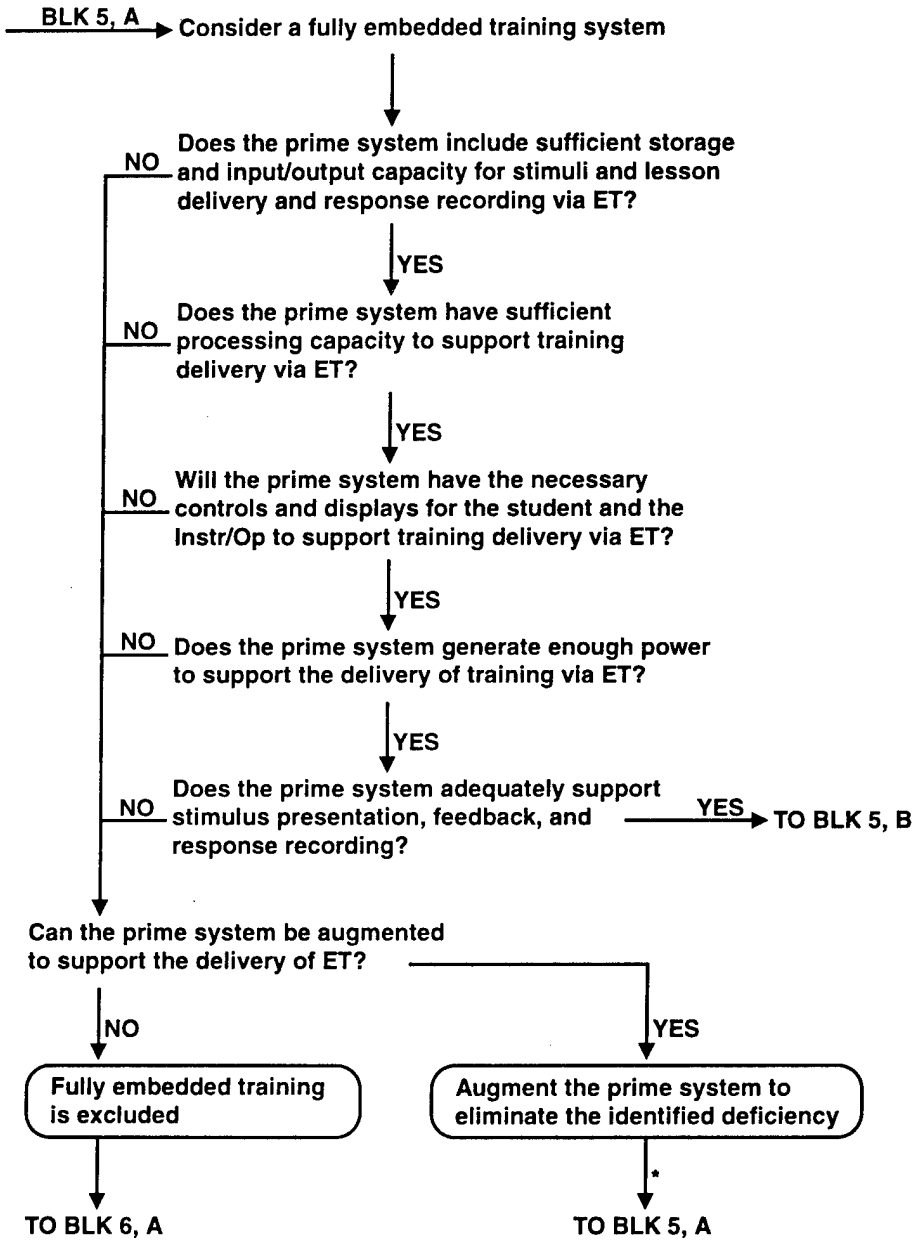
Phase III. Block 4 Help

Purpose: The purpose of this block is to determine whether the ranges and training facilities to support embedded training can be made available.

Rationale: A fully embedded training system that generates training scenarios might require very little in the way of training facilities or ranges. However, embedding a tactical engagement system such as **MILES** would require ranges for conducting training, and umbilical embedded systems that may be necessary for networked collective training may require other types of special training facilities.

If a lack of range facilities affects current training or would likely affect the use of the proposed training system, then the availability of any range facilities that would be required for embedded training might also be affected. If ET requires range facilities, then the situation is evaluated to determine if the required facilities are available or can be provided concurrent with ET fielding at a reasonable cost. If not, the feasibility of using SAD or other training alternatives is examined in Block 16. If range facilities are available or can be provided for ET, then the need for a training facility (e.g., a building to house embedded training umbilical components) is explored. If required ranges and other training facilities for ET are available, then ET is considered further in Block 5. If these facilities are not required for embedded training, then ET is also considered further in Block 5. If training facilities are needed and cannot be provided concurrent with ET fielding at a reasonable cost, then the use of SAD or other training alternatives is investigated in Block 16.

Phase III, Block 5A. Can the minimum requirements for a fully embedded training system be met?

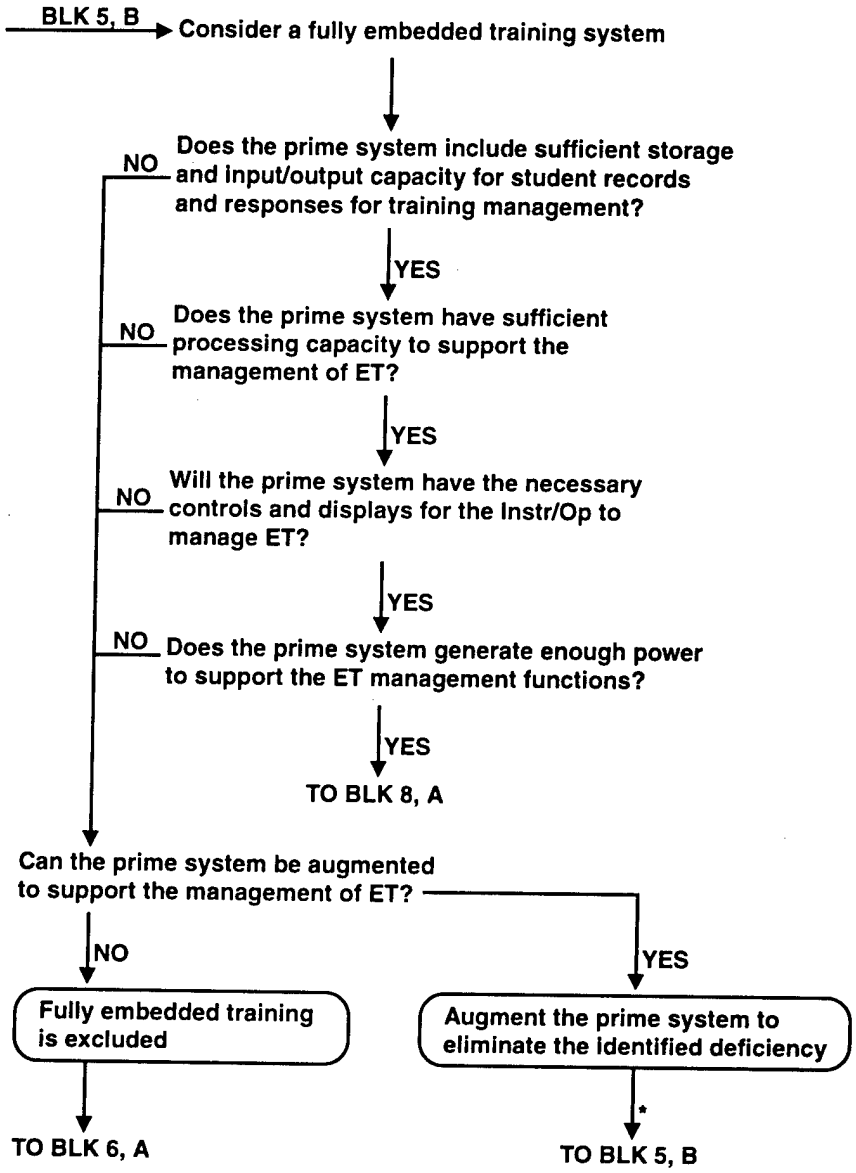


Phase III. Block 5A Help

Purpose: The purpose of this block is to evaluate the adequacy of the proposed prime system to accommodate use of a fully embedded training system to train the task, function, or mission being considered. If prime system characteristics cannot support this training, then the prime system might be modified to meet requirements by adding the features necessary to support the embedded training.

Rationale: A prime system that includes an embedded training capability must be designed to support that capability. The minimum requirements that the prime system must meet to support fully embedded training of the task, function, or mission are evaluated in this block. Minimum requirements for both delivery and management of embedded training are considered. Training management consists of those activities, primarily the collection, storage, and display of data, necessary to provide student feedback, track student progress, and sequence training. If the prime system as currently designed does not support one or more these requirements, then the feasibility of augmenting the prime system to meet the training requirement(s) is determined. If the system can be augmented, the capability to meet the minimum requirements following augmentation is reevaluated by repeating the Block 5 analysis. If augmentation is not possible, then the fully embedded training system alternative is eliminated from further consideration for the task, function, or mission and an appended embedded training system is considered in Block 6. If all of the minimum requirements for using a fully embedded training system have been satisfied, then the fully embedded training system is considered further in Block 8.

Phase III, Block 5B.
Can the minimum requirements for a fully embedded training system be met?

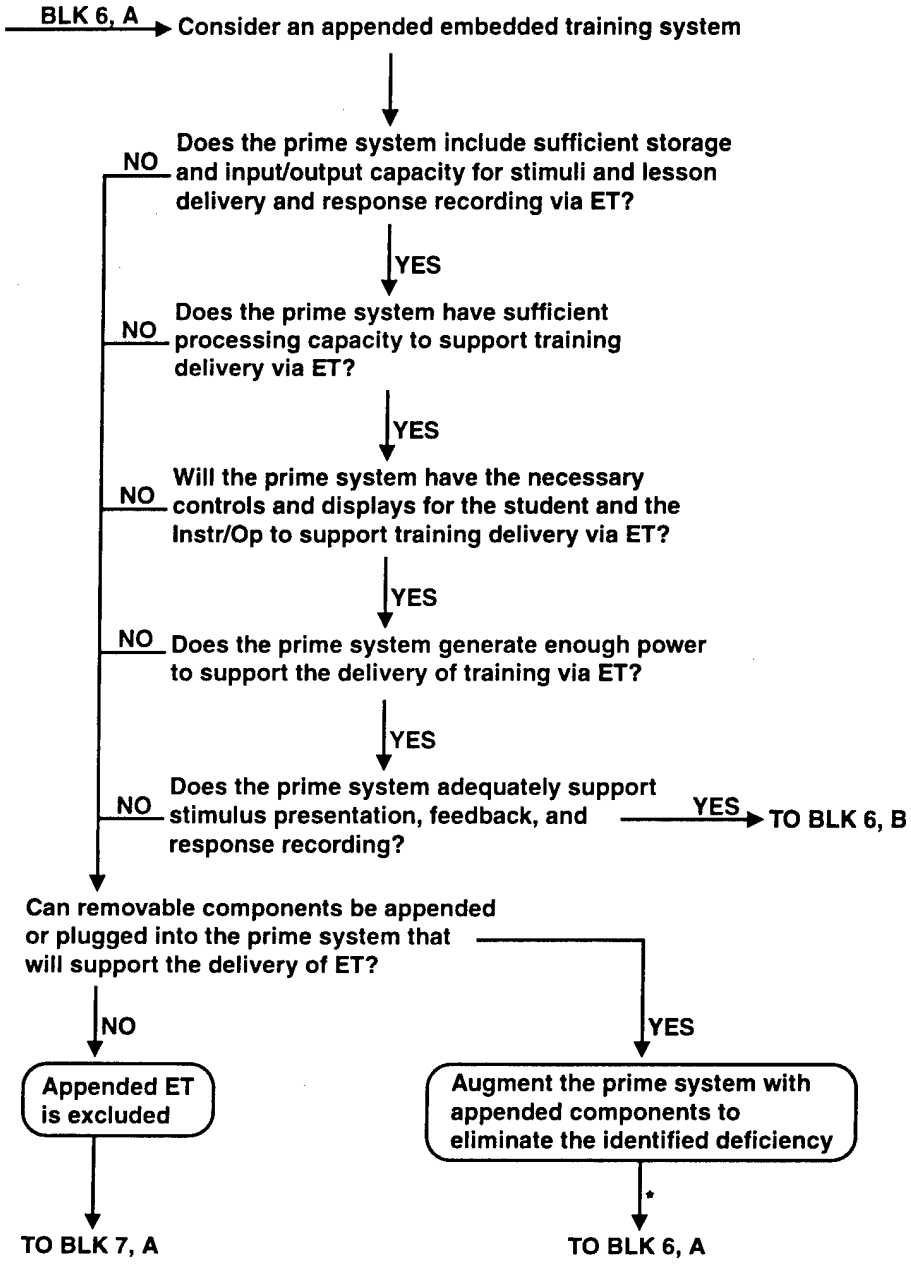


Phase III. Block 5B Help

Purpose: The purpose of this block is to evaluate the adequacy of the proposed prime system to accommodate use of a fully embedded training system to train the task, function, or mission being considered. If prime system characteristics cannot support this training, then the prime system might be modified to meet requirements by adding the features necessary to support the embedded training.

Rationale: A prime system that includes an embedded training capability must be designed to support that capability. The minimum requirements that the prime system must meet to support fully embedded training of the task, function, or mission are evaluated in this block. Minimum requirements for both delivery and management of embedded training are considered. Training management consists of those activities, primarily the collection, storage, and display of data, necessary to provide student feedback, track student progress, and sequence training. If the prime system as currently designed does not support one or more these requirements, then the feasibility of augmenting the prime system to meet the training requirement(s) is determined. If the system can be augmented, the capability to meet the minimum requirements following augmentation is reevaluated by repeating the Block 5 analysis. If augmentation is not possible, then the fully embedded training system alternative is eliminated from further consideration for the task, function, or mission and an appended embedded training system is considered in Block 6. If all of the minimum requirements for using a fully embedded training system have been satisfied, then the fully embedded training system is considered further in Block 8.

Phase III, Block 6A.
Can the minimum requirements for an appended embedded training system be met?

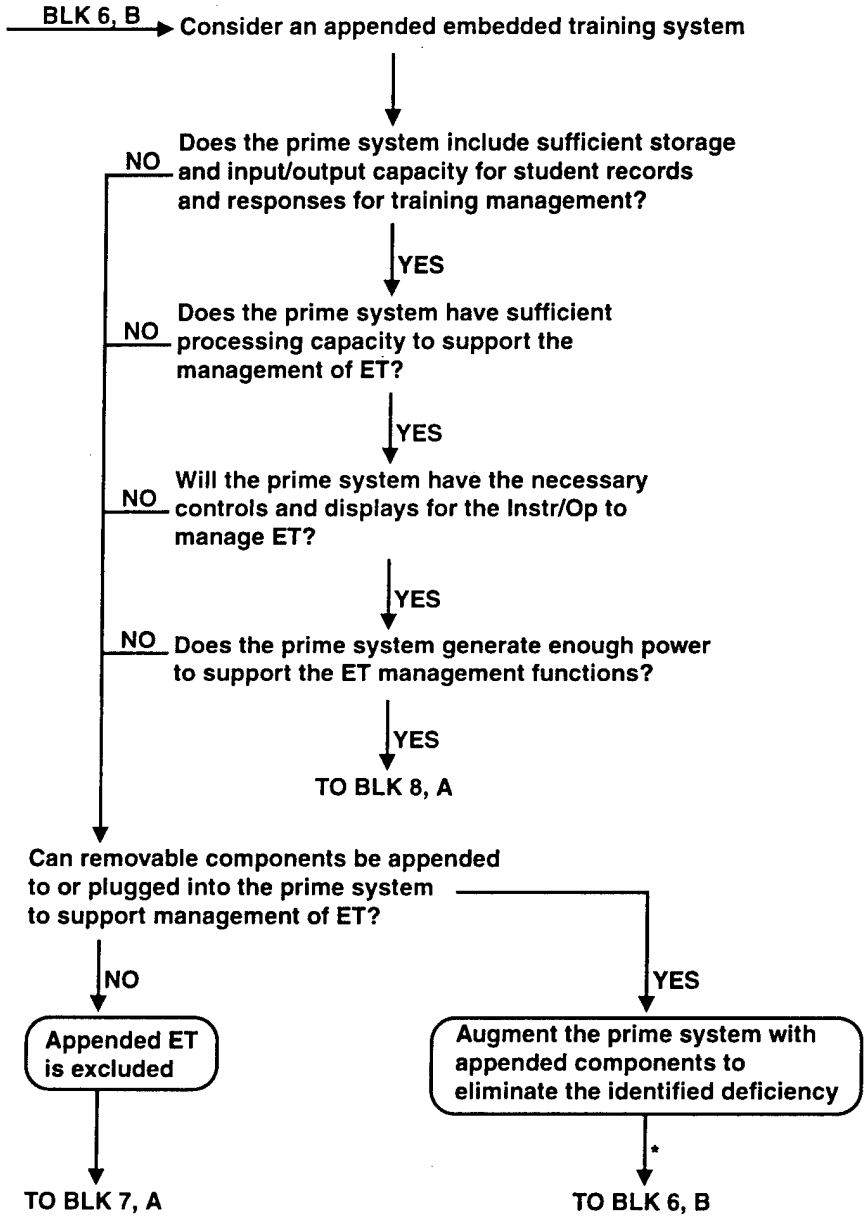


Phase III. Block 6A Help

Purpose: The purpose of this block is to evaluate the adequacy of the proposed prime system to accommodate use of an appended embedded training system to train the task, function, or mission being considered. If prime system characteristics cannot support this training, then the prime system might be modified to meet requirements by appending components to the prime system to support embedded training.

Rationale: A prime system that includes an embedded training capability must be designed to support that capability. The minimum requirements that the prime system must meet to support appended embedded training of the task, function, or mission are evaluated in this block. Minimum requirements for both delivery and management of embedded training are considered. Training management consists of those activities, primarily the collection, storage, and display of data, necessary to provide student feedback, track student progress, and sequence training. If the prime system as currently designed does not support one or more of these requirements, then the feasibility of making design changes to the prime system to accommodate the necessary appended embedded components is determined. If the system can be augmented, the capability to meet the minimum requirements following augmentation is reevaluated by repeating the Block 6 analysis. If augmentation is not possible, then the appended embedded training system alternative is eliminated as the alternative for training the task, function, or mission and an umbilical embedded training system is considered in Block 7. If all of the minimum requirements have been satisfied for using an appended embedded training system, then appended embedded training is considered further in Block 8.

Phase III, Block 6B. Can the minimum requirements for an appended embedded training system be met?

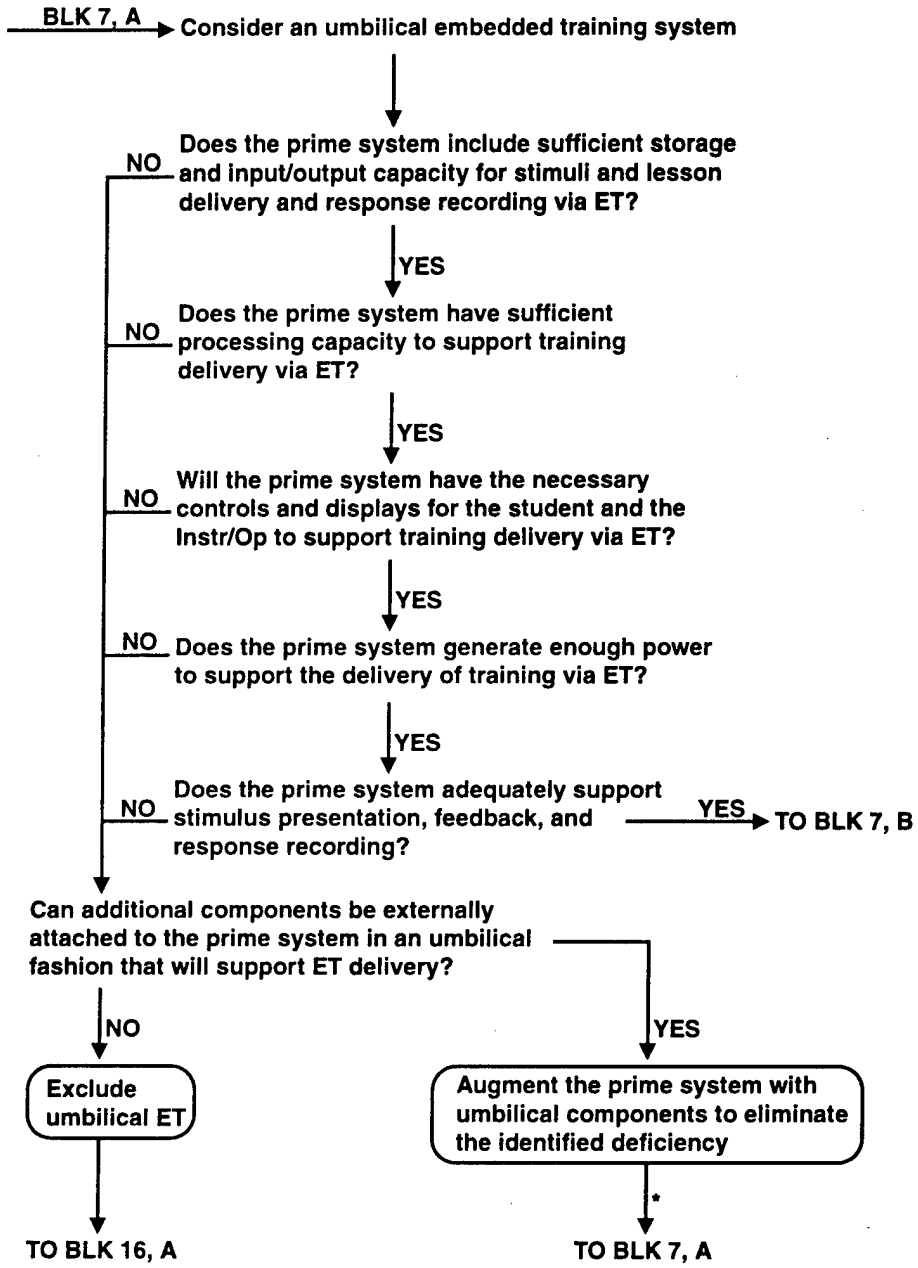


Phase III. Block 6B Help

Purpose: The purpose of this block is to evaluate the adequacy of the proposed prime system to accommodate use of an appended embedded training system to train the task, function, or mission being considered. If prime system characteristics cannot support this training, then the prime system might be modified to meet requirements by appending components to the prime system to support embedded training.

Rationale: A prime system that includes an embedded training capability must be designed to support that capability. The minimum requirements that the prime system must meet to support appended embedded training of the task, function, or mission are evaluated in this block. Minimum requirements for both delivery and management of embedded training are considered. Training management consists of those activities, primarily the collection, storage, and display of data, necessary to provide student feedback, track student progress, and sequence training. If the prime system as currently designed does not support one or more of these requirements, then the feasibility of making design changes the prime system to accommodate the necessary appended embedded components is determined. If the system can be augmented, the capability to meet the minimum requirements following augmentation is reevaluated by repeating the Block 6 analysis. If augmentation is not possible, then the appended embedded training system alternative is eliminated as the alternative for training the task, function, or mission and an umbilical embedded training system is considered in Block 7. If all of the minimum requirements have been satisfied for using an appended embedded training system, then appended embedded training is considered further in Block 8.

Phase III, Block 7A.
Can the minimum requirements for an umbilical type embedded training system be met?

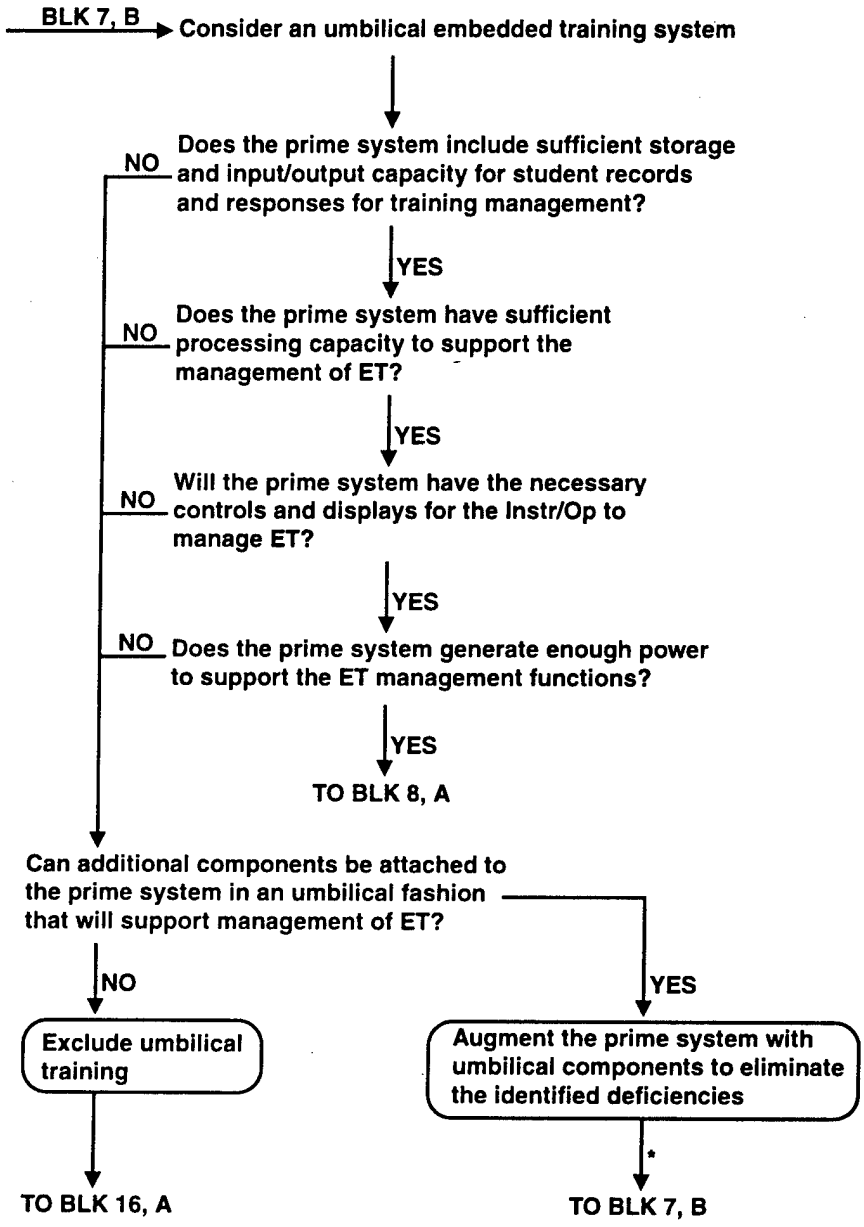


Phase III. Block 7A Help

Purpose: The purpose of this block is to evaluate the adequacy of the proposed prime system to accommodate use of umbilical ET to train the task, function, or mission being considered. If prime system characteristics cannot support this training, then the prime system might be modified to meet requirements by augmenting the training system with external umbilically linked components.

Rationale: A prime system that includes an umbilical embedded training capability must be designed to support that capability. The minimum requirements that the prime system must meet to support umbilical embedded training of the task, function, or mission are evaluated in this block. Minimum requirements for both delivery and management of embedded training are considered. Training management consists of those activities, primarily the collection, storage, and display of data, necessary to provide student feedback, track student progress, and sequence training. If the prime system as currently designed does not support one or more of these requirements, then the feasibility of making design changes to the prime system to interface with and compliment the necessary umbilical embedded components is determined. If the system can be augmented, the capability to meet the minimum requirements following augmentation is reevaluated by repeating the Block 7 analysis. If augmentation is not possible, then the umbilical embedded training system alternative is eliminated for the task, function, or mission and simulation alternatives to embedded training are considered in Block 16. If all of the minimum requirements have been satisfied for using an umbilical embedded training system, then the umbilical ET system is considered further in Block 8.

Phase III, Block 7B.
Can the minimum requirements for an umbilical type embedded training system be met?

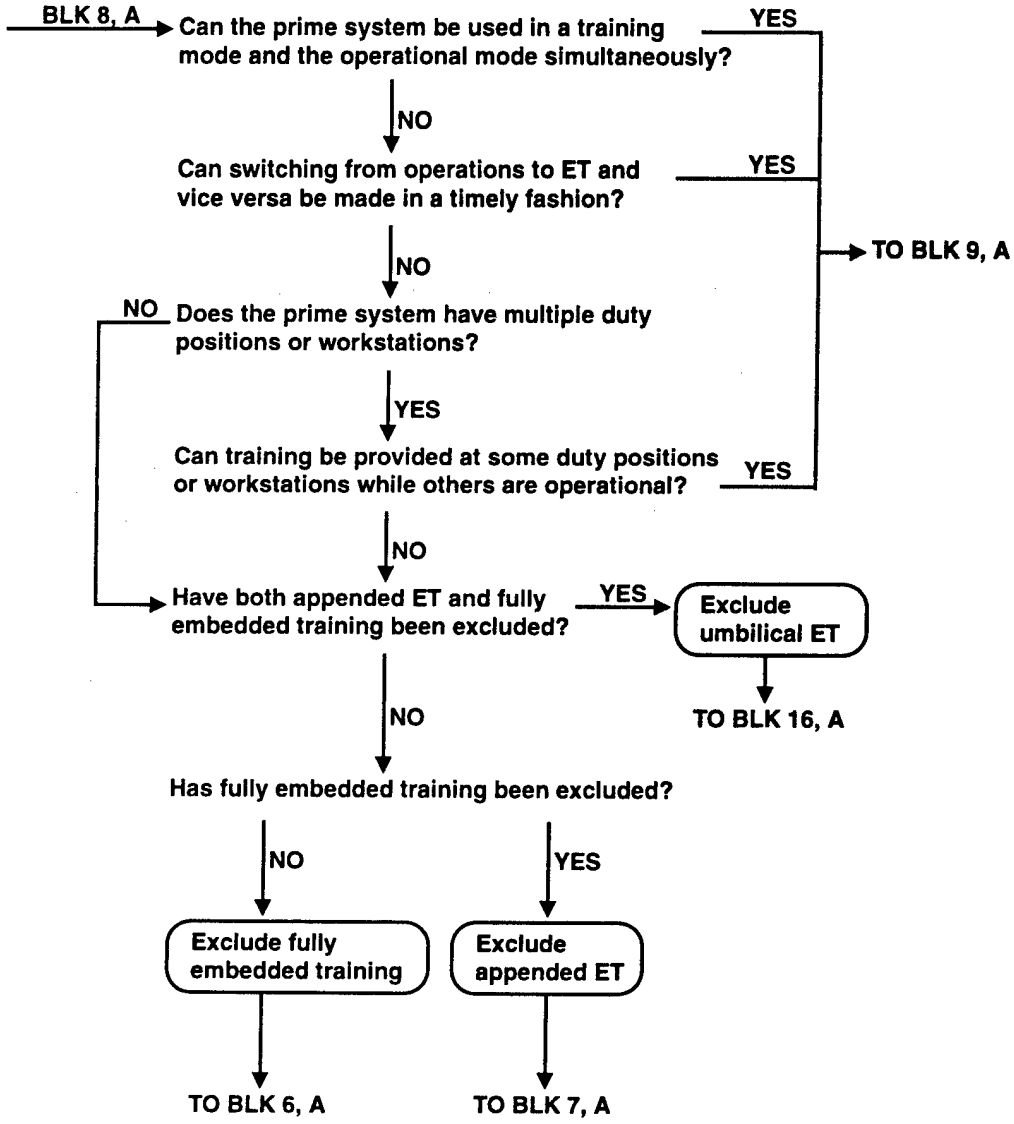


Phase III. Block 7B Help

Purpose: The purpose of this block is to evaluate the adequacy of the proposed prime system to accommodate use of umbilical ET to train the task, function, or mission being considered. If prime system characteristics cannot support this training, then the prime system might be modified to meet requirements by augmenting the training system with external umbilically linked components.

Rationale: A prime system that includes an umbilical embedded training capability must be designed to support that capability. The minimum requirements that the prime system must meet to support umbilical embedded training of the task, function, or mission are evaluated in this block. Minimum requirements for both delivery and management of embedded training are considered. Training management consists of those activities, primarily the collection, storage, and display of data, necessary to provide student feedback, track student progress, and sequence training. If the prime system as currently designed does not support one or more of these requirements, then the feasibility of making design changes to the prime system to interface with and compliment the necessary umbilical embedded components is determined. If the system can be augmented, the capability to meet the minimum requirements following augmentation is reevaluated by repeating the Block 7 analysis. If augmentation is not possible, then the umbilical embedded training system alternative is eliminated for the task, function, or mission and simulation alternatives to embedded training are considered in Block 16. If all of the minimum requirements have been satisfied for using an umbilical embedded training system, then the umbilical ET system is considered further in Block 8.

Phase III, Block 8.
Will prime systems operations adversely affect ET and vice versa?



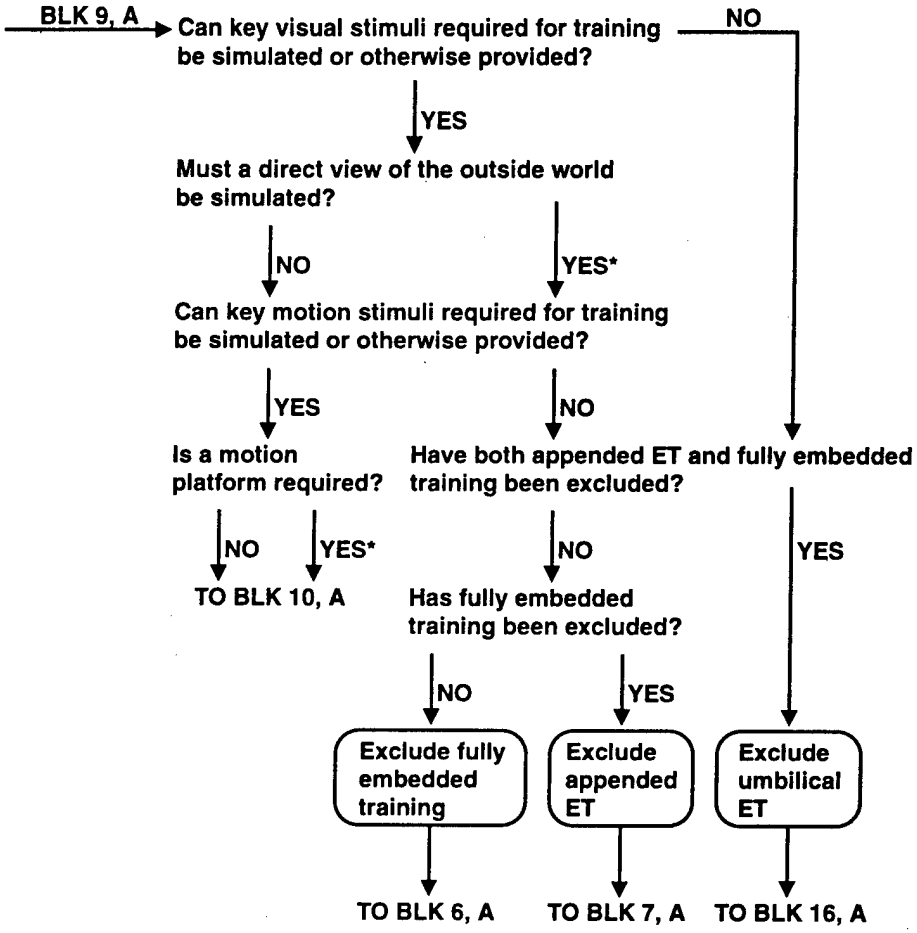
Phase III. Block 8 Help

Purpose: The purpose of this block is to determine how readily the prime system may be converted from use as an embedded trainer to use as an operational system and vice versa. This block also explores the possibility that the prime system can be used for training and in an operational capacity simultaneously. Finally, for prime systems that have multiple duty positions or workstations, the feasibility of conducting embedded training at one workstation while system operations are performed at another workstation is determined.

Rationale: Because embedded training entails the use of prime system operator controls and displays, there is potentially a built-in conflict between using the prime system to perform its operational mission and employing it in its embedded training role. If the prime system can be used for operations and training simultaneously or if switching from the embedded training mode to the operational mode can be done quickly, then there is no conflict and embedded training is considered further in Block 9. If not, the possibility exists that training can be provided at some workstations while others remain operation. If this is the case, then embedded training is considered further in Block 9. If none of these conditions can be met, then the particular type of embedded training system being considered is excluded and other training system alternatives are evaluated. Excluding a particular ET option for one particular task, function, or mission does not necessarily eliminate that option from further consideration for other tasks, functions, or missions.

Excluding an embedded training alternative leads to the consideration of the next embedded training option until a suitable ET option is identified for the task, function, or mission, or until all ET options are exhausted. It may be necessary to cycle through this block as many as three times, one time each for fully embedded training, appended ET, and umbilical ET.

Phase III, Block 9.
Does the embedded training system require visual system or motion system simulation?



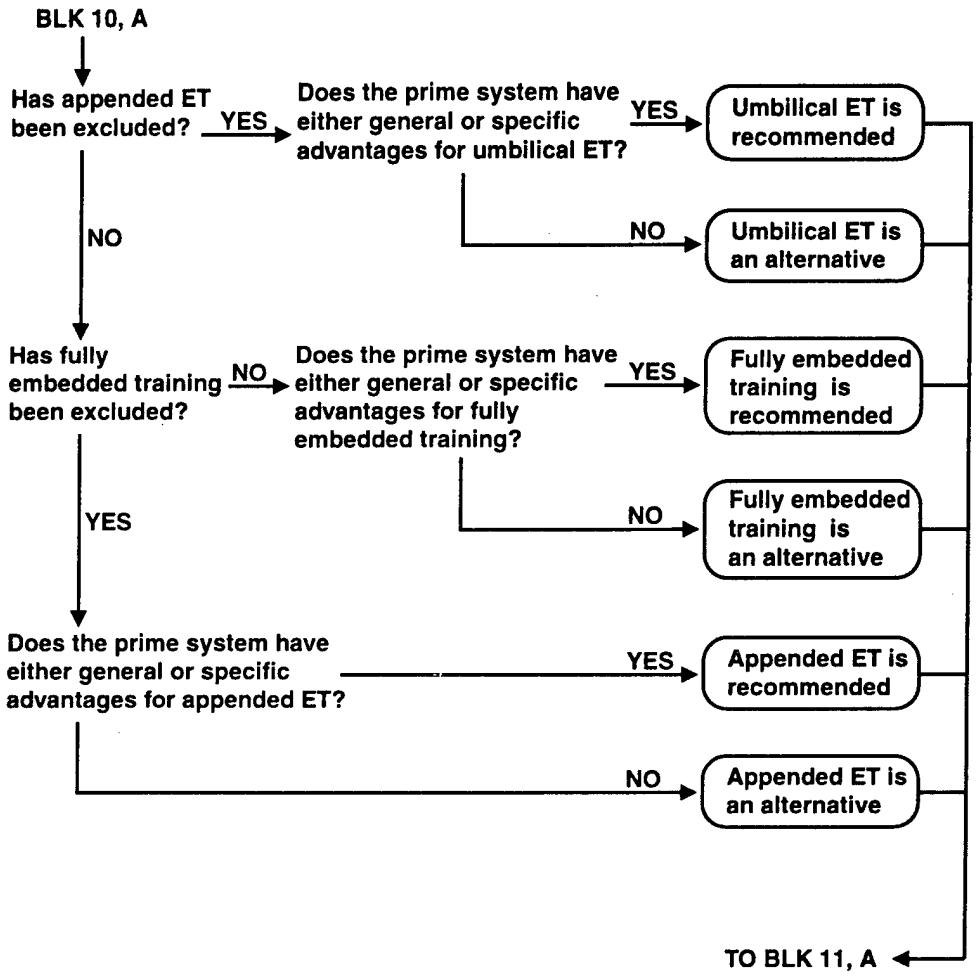
Phase III. Block 9 Help

Purpose: The purpose of this block is to determine how requirements for simulating visual or motion stimuli influence the selection of an embedded training system.

Rationale: Requirements for simulation of real-world scenes and requirements for a motion platform to provide the motion cues may affect the embedded training configuration selected. Requirements to provide extensive visual system and motion cues may also drive up the costs of the embedded training system. Identification of these cost drivers allows the analyst to reconsider the requirements that produced them. If key visual stimuli can be provided (i.e., if it is technically feasible to provide them), then the need to simulate a direct view of the outside world is determined. If a direct view must be simulated, then the cost of the simulation is likely to be high. The capability of the embedded training system to simulate key motion stimuli is then evaluated. If motion stimuli can be provided, the requirement for a motion platform is determined. The need for a motion platform also suggests that the simulation will be costly.

Key visual and motion stimuli are those stimuli that must be presented during training in order for the tasks to be performed and evaluated. If the key visual and motion stimuli can be provided, embedded training is evaluated further in Block 10. If key stimuli cannot be provided, then the embedded training option under consideration is excluded. Excluding an embedded training alternative leads to the consideration of the next embedded training option until a suitable ET option is identified or until all ET options are exhausted. It may be necessary to cycle through this block as many as three times, one time each for fully embedded training, appended ET, and umbilical ET. Excluding a particular ET option for one particular task, function, or mission does not necessarily eliminate that ET option from further consideration for other tasks, functions, or missions.

Phase III, Block 10.
Does the prime system have general or specific advantages for ET alternatives?



Phase III. Block 10 Help

Purpose: The purpose of this block is to determine whether the prime system has either general or specific advantages for the particular embedded training system under consideration. That is, does the prime system include specific design features or general characteristics that are advantageous to including embedded training simply and inexpensively?

Rationale: The embedded training option to be evaluated is determined by eliminating from consideration those options that have already been examined and excluded. The option is then considered with respect to the advantages that the prime system may provide in its implementation. If the prime system provides any general or specifc advantages for the embedded training option, then that ET option is recommended. If, conversely, the prime system provides no advantages for ET, then that ET option is one alternative to be considered along with other training system alternatives. In either case the ET option is considered further in Block 11. The general and specific advantages that the prime system may have for embedded training are listed below.

General advantages for ET:

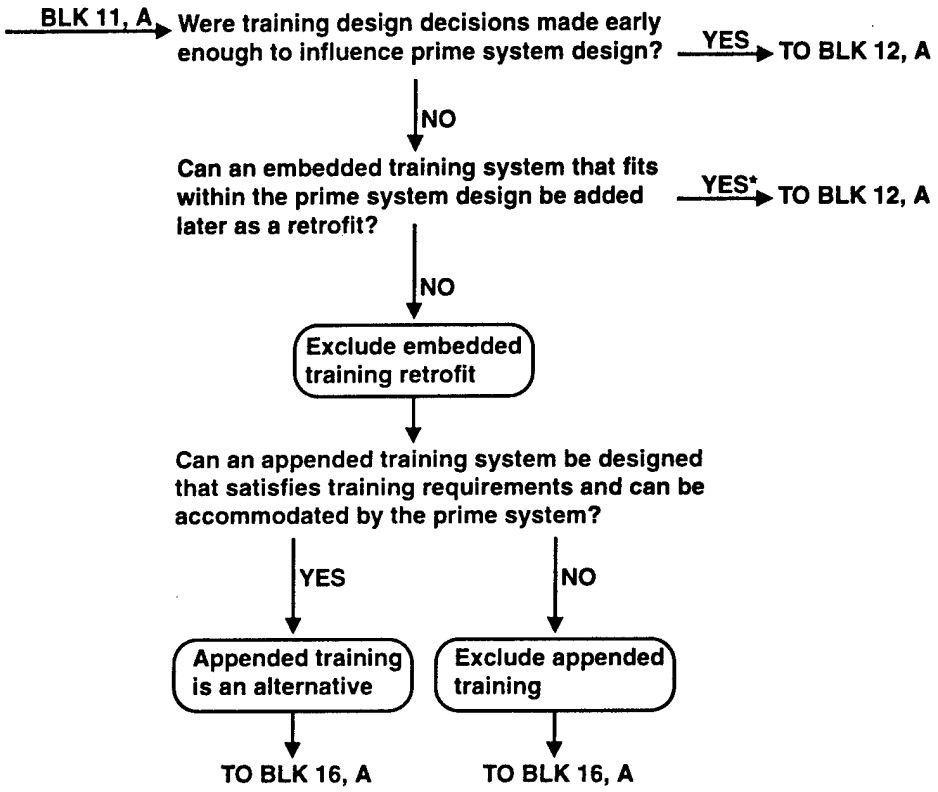
1. System output to the operator and operator input to the system is primarily through electronic modes
2. System has electronic rather than mechanical or hydraulic control linkages
3. System has electronic links to other vehicles, units, or systems
4. System characteristics indicate the need or possibility for automated instructor functions

Specific advantages for ET that could not be practically duplicated by a simulator or training device:

1. Superior stimulus presentation (e.g., high degree of realism in presenting terrain)
2. Unique feedback presentation
3. More reliable and valid performance evaluation

A prime system that has electronic interfaces to the operator and within or across system workstations is advantageous for embedded training applications because the embedded training system is likely to be controlled electronically via a digital computer. If the use of the prime system for training rquires an instructor and space limitations or personnel constraints prevent the use of a live instructor, then an embedded training system has the advantage of possibly providing an automated instructor to perform the needed instructional functions.

Phase III, Block 11. Is a system retrofit necessary in order to use ET?



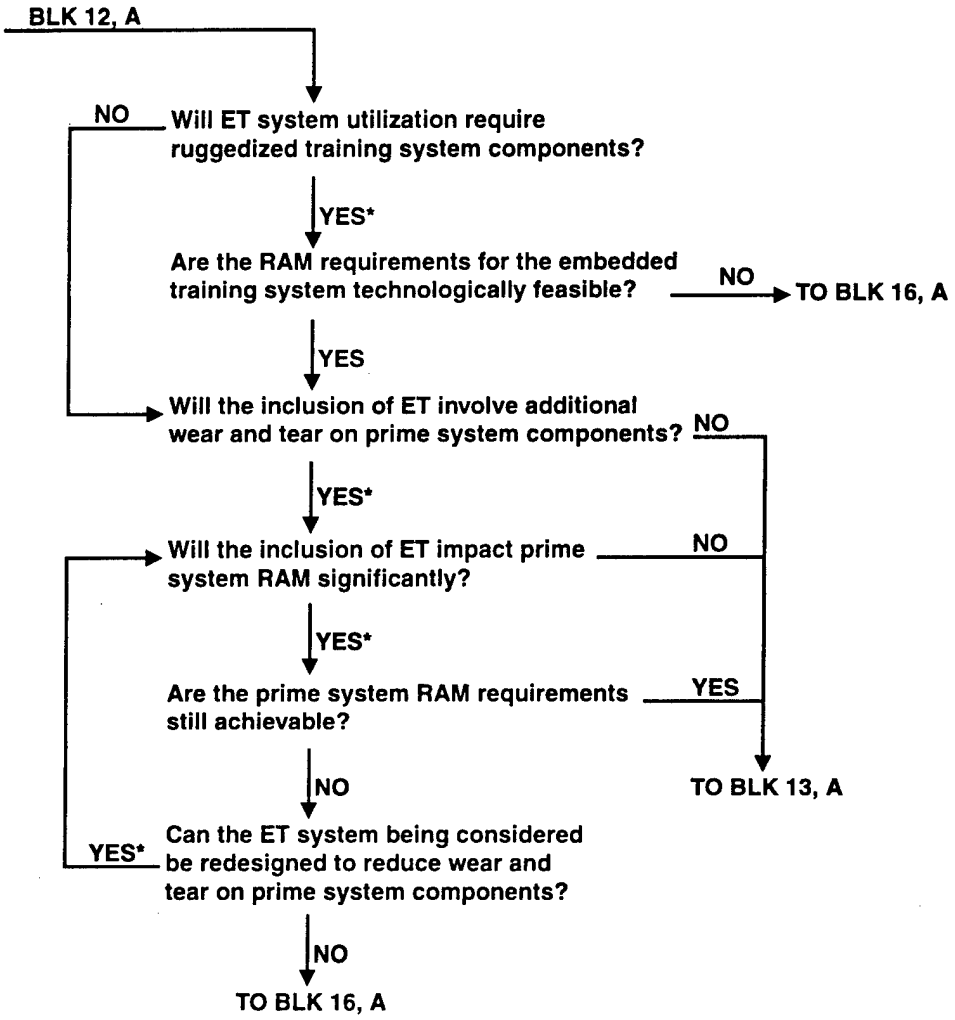
Phase III. Block 11 Help

Purpose: The purpose of this block is to determine whether training design decisions were made early enough to influence prime system design or, if not, whether an embedded training system can be retrofitted to the existing prime system design.

Rationale: If the necessary prime system design decisions were made early enough, or an ET system retrofit is feasible, then ET is considered further in Block 12. If the training system cannot accommodate an ET system retrofit, then ET is excluded and the feasibility of designing an appended device that satisfies the requirement is investigated. If an appended device is feasible, it is suggested as an alternative; if not, then appended devices are excluded. In either case, SADs and other training alternatives are considered further in Block 16. Excluding a particular ET option or simulation alternative for a given task, mission, or function does not necessarily eliminate that training option from further consideration for other tasks, functions, or missions.

An embedded training retrofit differs from an appended device in several respects. First, the retrofit will likely require changes to the prime system, whereas the appended device should not. If the appended device requires modification of the prime system, the changes should be relatively minor and involve connecting the appended device to the prime system. On the other hand, an ET retrofit may require major changes to the prime system such as a larger prime system computer or the hardening of prime system components to withstand constant training use. Second, the appended device is removable by definition, whereas the ET retrofit may employ permanently installed training system components.

Phase III, Block 12.
Can the RAM requirements associated with embedded training be met?

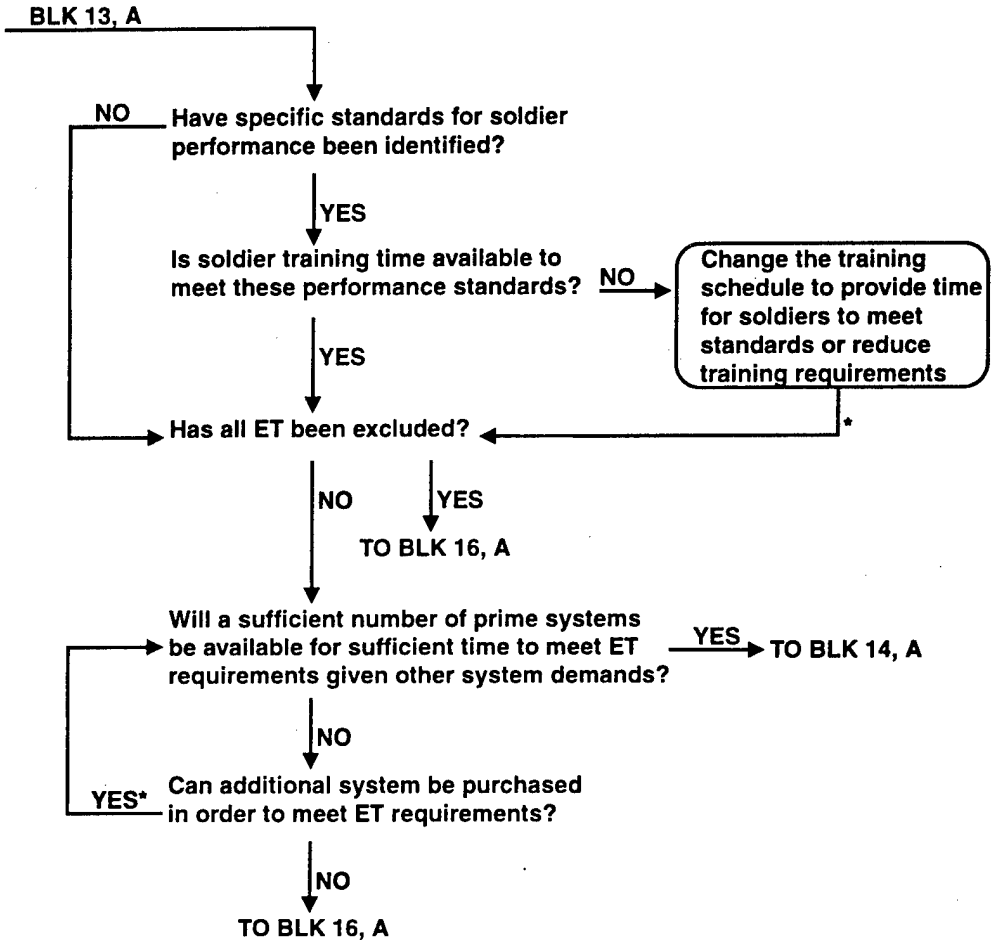


Phase III. Block 12 Help

Purpose: The purpose of this block is to determine whether the Reliability, Availability, and Maintainability (RAM) requirements associated with embedded training can be met. RAM requirements for both the embedded training system and the prime system are evaluated.

Rationale: The components in a fully embedded training system and some components in an appended embedded training system must be as rugged and meet the same specifications as the prime system components because they are likely to be exposed to the same conditions as the prime system during operations. Some appended embedded system components must be rugged enough to withstand vibration and temperature extremes found in a field training environment, but may be removed prior to going into combat. Other components in an appended embedded training system are a permanent part of the prime system and must be as rugged as the prime system components. If the embedded training system components require ruggedization, then the capability of the embedded training system to meet RAM requirements is assessed. If meeting the RAM requirements for the ET system is not feasible, then training system alternatives are considered in Block 16. If ET RAM requirements can be met or ruggedization of the training system is not required, then the amount of wear and tear that ET will place on the prime system is evaluated to determine if it has a significant impact on prime system RAM (i.e., RAM requirements can no longer be met). If RAM requirements cannot be achieved because of the impact of ET on prime system components, the option of redesigning ET to have less impact on prime system RAM is considered. If ET has no significant RAM impacts on prime system components, if the RAM requirements are still achievable despite any adverse impacts, or if ET can be redesigned so that the RAM impacts are achievable, then embedded training is considered further in Block 13. Otherwise alternative training options are considered in Block 16.

Phase III, Block 13.
Will soldiers and prime systems be available for sufficient time to meet ET requirements?



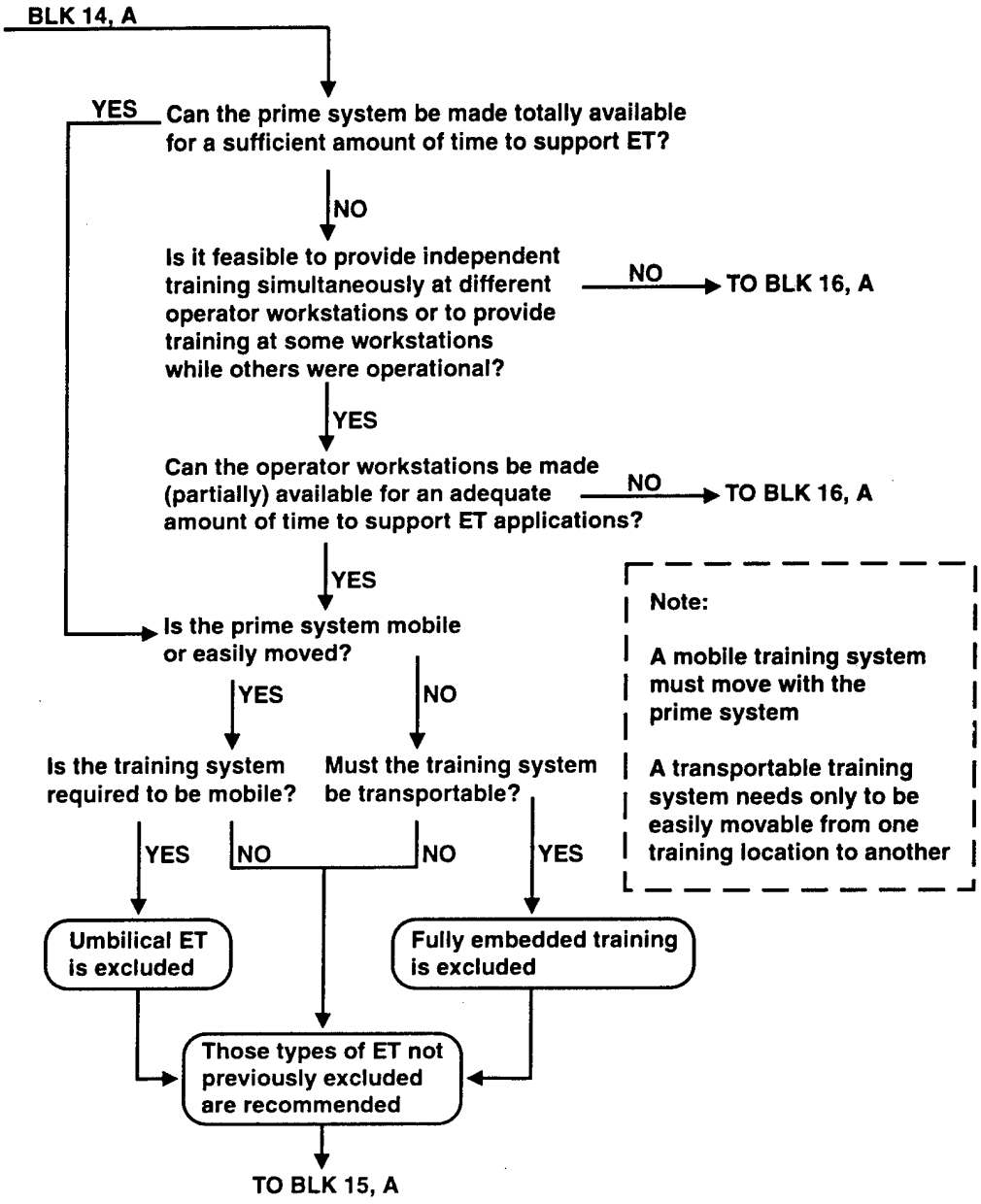
Phase III. Block 13 Help

Purpose: The purpose of this block is to determine if the soldiers and prime systems will be available for sufficient time to meet training requirements.

Rationale: The time that a training system can be made available for training is a major determinant of its ability to meet training requirements. With embedded training, the use of the prime system in its operational capacity may interfere with its use for training. On the other hand, soldiers may have better access to a training system that is embedded in their own operational equipment than they would to a stand-alone trainer that resides in a remotely located training facility. However, even if a training system is available for training 24 hours a day, little training will be done unless the soldier is also available for training.

The availability of the soldier for an adequate period of time to meet performance standards, given other required training and duties, is determined first. In evaluating the time available for training, consider that ET may provide training more efficiently than current methods. If more training time is needed to meet standards, then the training schedule must be changed to allow more time for training the required skills or training requirements must be reduced. One way to reduce training requirements is to redesign the prime system operator interface. Another way is to reduce training standards. If performance standards can be met or if specific standards cannot be identified, then the availability of the prime system for training is determined. To meet training requirements, an adequate number of systems must be available for training purposes for a sufficient amount of time. If prime system availability is inadequate, it may be possible to purchase additional systems strictly for training purposes, given that these systems are not too costly. If a sufficient number of systems cannot be made available, then other training system alternatives are considered in Block 16. If prime system availability is sufficient for training, then embedded training is considered further in Block 14.

Phase III, Block 14. Are the prime systems or their individual workstations available at training sites to support ET?



Phase III. Block 14 Help

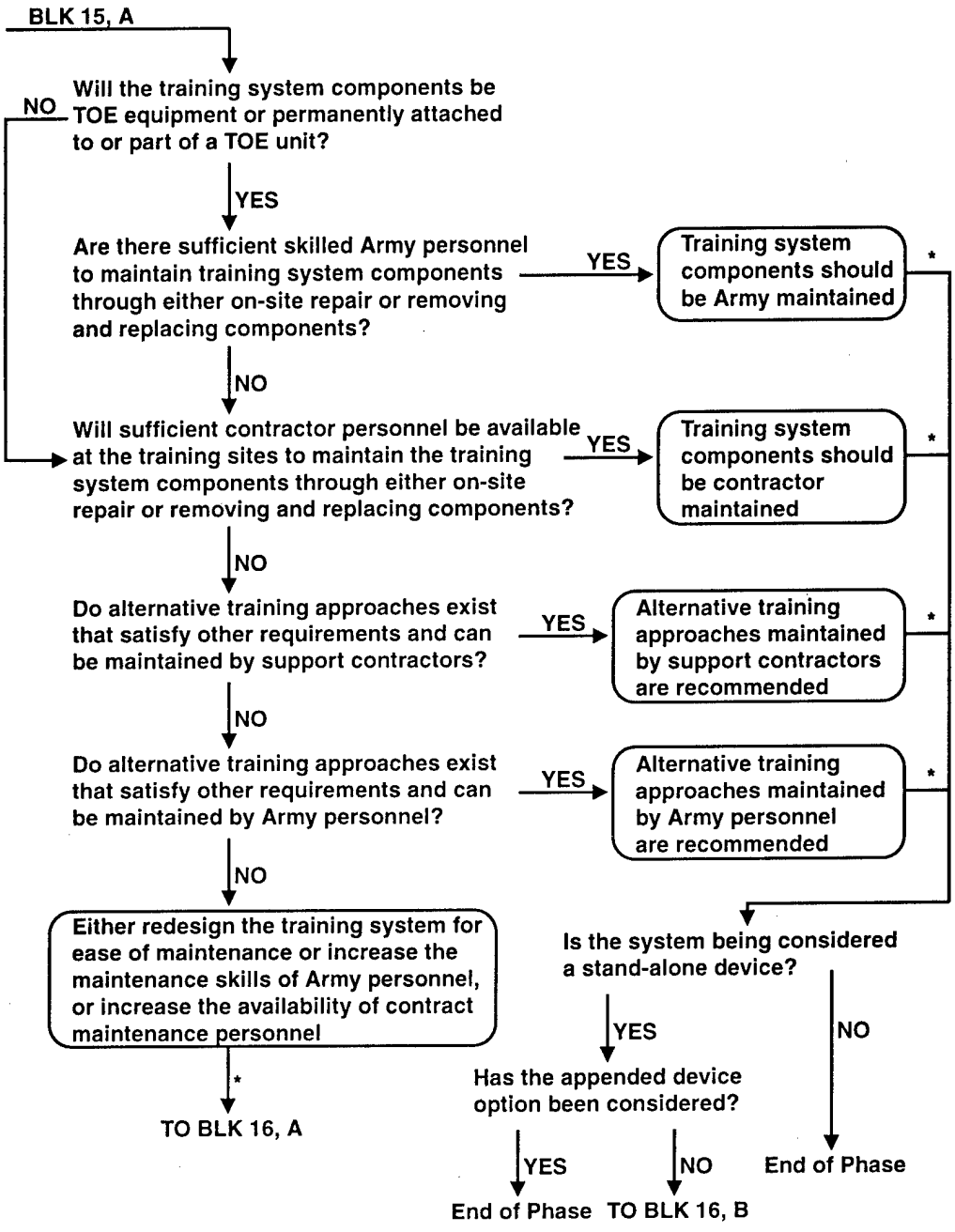
Purpose: The type of embedded training selected and how it is configured will determine, in part, its availability. The purpose of this block is to evaluate the proposed embedded training system availability in order to maximize it and to select the embedded training system that best meets availability requirements.

Rationale: If the prime system cannot be made totally available for a sufficient amount of time to satisfy training requirements for a particular mission, function, or task, training time may be increased in effect by designing the embedded training so that independent training can be provided simultaneously at different workstations or to provide training at some workstations while others are operational. If the time that workstations are partially available for ET is sufficient, then requirements for training system mobility and transportability are explored. If the time that the prime system is partially available for training is not sufficient, then other training alternatives are investigated in Block 16. If the prime system can be made either fully available or partially available for an adequate amount of time to support embedded training, then requirements for training system mobility and transportability are examined.

A mobile training system must by definition move with the prime system. One reason to require the training system to move with the prime system is to use the training system in realistic moving vehicle exercises. Another reason is to make the training readily available to soldiers wherever they take their operational system. A transportable training system is one that can be moved from one training site to another relatively easily, but must be moved apart from the prime system. As defined here a transportable system should not require extensive preparation for relocation.

If the prime system neither moves nor can be easily moved, and the training system must be transportable from one training site to another, then fully embedded training is not a viable alternative because a fully embedded system must stay with the system in which it is embedded. If the training system need not be moved, then all types of ET that have not been specifically excluded can be used with an immovable prime system. If the prime system can move and the training system is required to move with it, umbilical ET is eliminated as an option because some umbilical components by definition are physically separate from the prime system. If the prime system can move easily, but there is no requirement for the training system to move with it, then all three types of embedded training are options unless an option was specifically excluded in a previous step. After the embedded training options have been identified, maintenance of the training system is considered in Block 15.

Phase III, Block 15. Does the manner in which training system components must be maintained affect training system selection and vice versa?



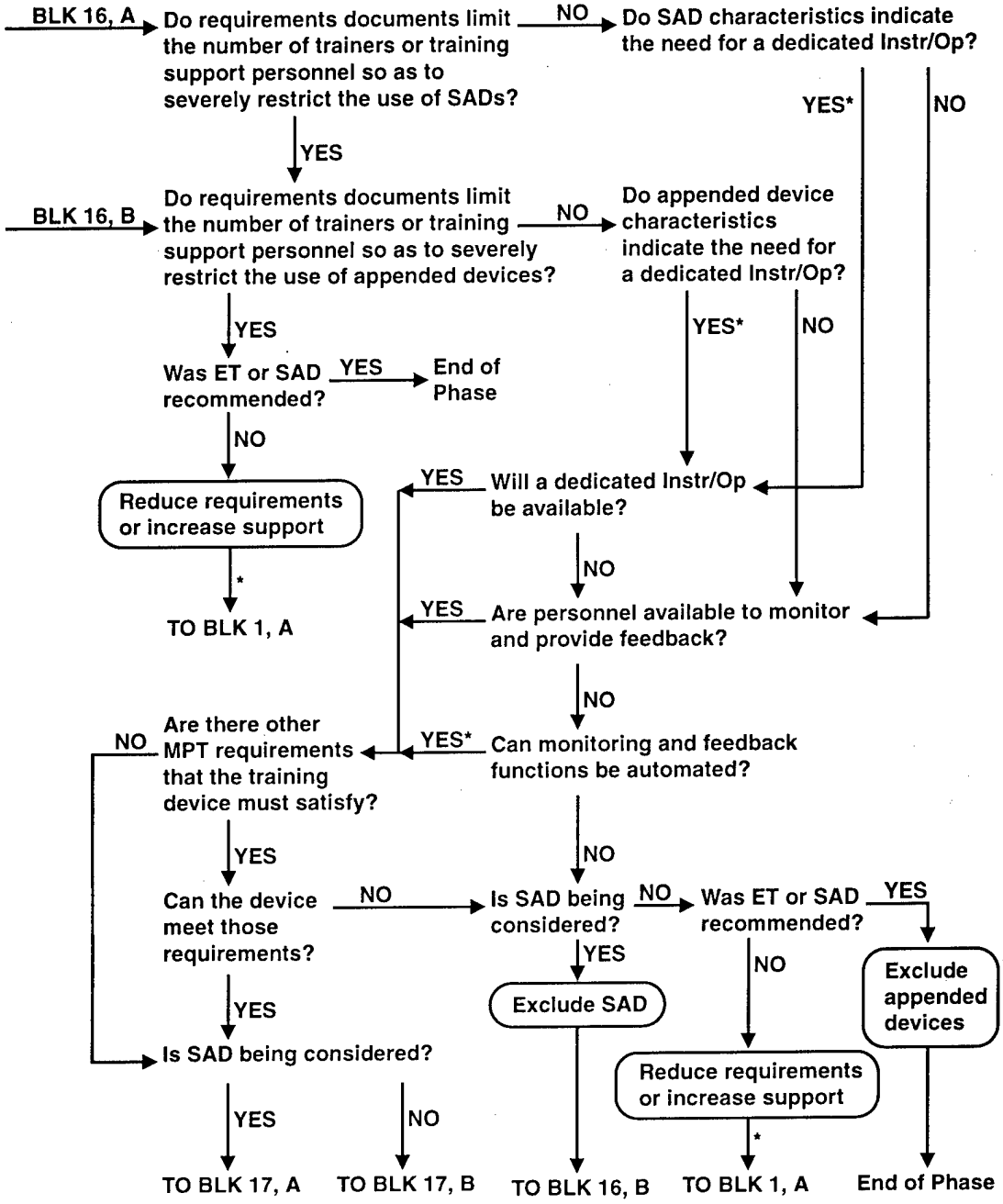
Phase III. Block 15 Help

Purpose: The purpose of this block is to determine how the system maintenance concept affects training system selection and how the type of training system selected, in turn, affects how the system components should be maintained.

Rationale: The Army is generally responsible for maintenance of all equipment found in the Table of Organization and Equipment (TOE). Army equipment is typically maintained either by Army personnel or by contractor personnel. Different costs are associated with each maintenance option. If the training system components will be TOE equipment or permanently attached to TOE equipment, and there will be sufficient skilled Army personnel to maintain them, then the components should be maintained by those personnel. If the training system components are not TOE or if there are insufficient Army maintainers, then the components should be maintained by contractors if enough contract maintainers are available at the training sites to perform the required maintenance. If the required contractor maintenance cannot be provided, alternative training approaches are considered to determine if they can be maintained either by support contractors or by Army personnel. If alternative training approaches can be maintained by contract support personnel and still satisfy other requirements, then those training approaches are recommended. Similarly, if alternative training approaches can be maintained by Army personnel and also satisfy other requirements, then those alternative training approaches are recommended.

If no training alternatives can be identified that can be maintained by either the Army or a contractor, then action must be taken to ensure that the training system can be maintained. One course of action would be to redesign the training system so that it requires less maintenance or becomes easier to maintain. Another solution is to increase the number of skilled Army maintenance personnel so that the system can be supported. Finally, the availability of contract maintenance personnel can be increased to meet the training system maintenance requirements. Following any of these actions, the analyst must return to the beginning of Block 15 and reevaluate the training system maintenance requirement.

Phase III, Block 16. Do the number of trainers or support personnel allowed by requirements documents limit the use of SAD or appended training devices?



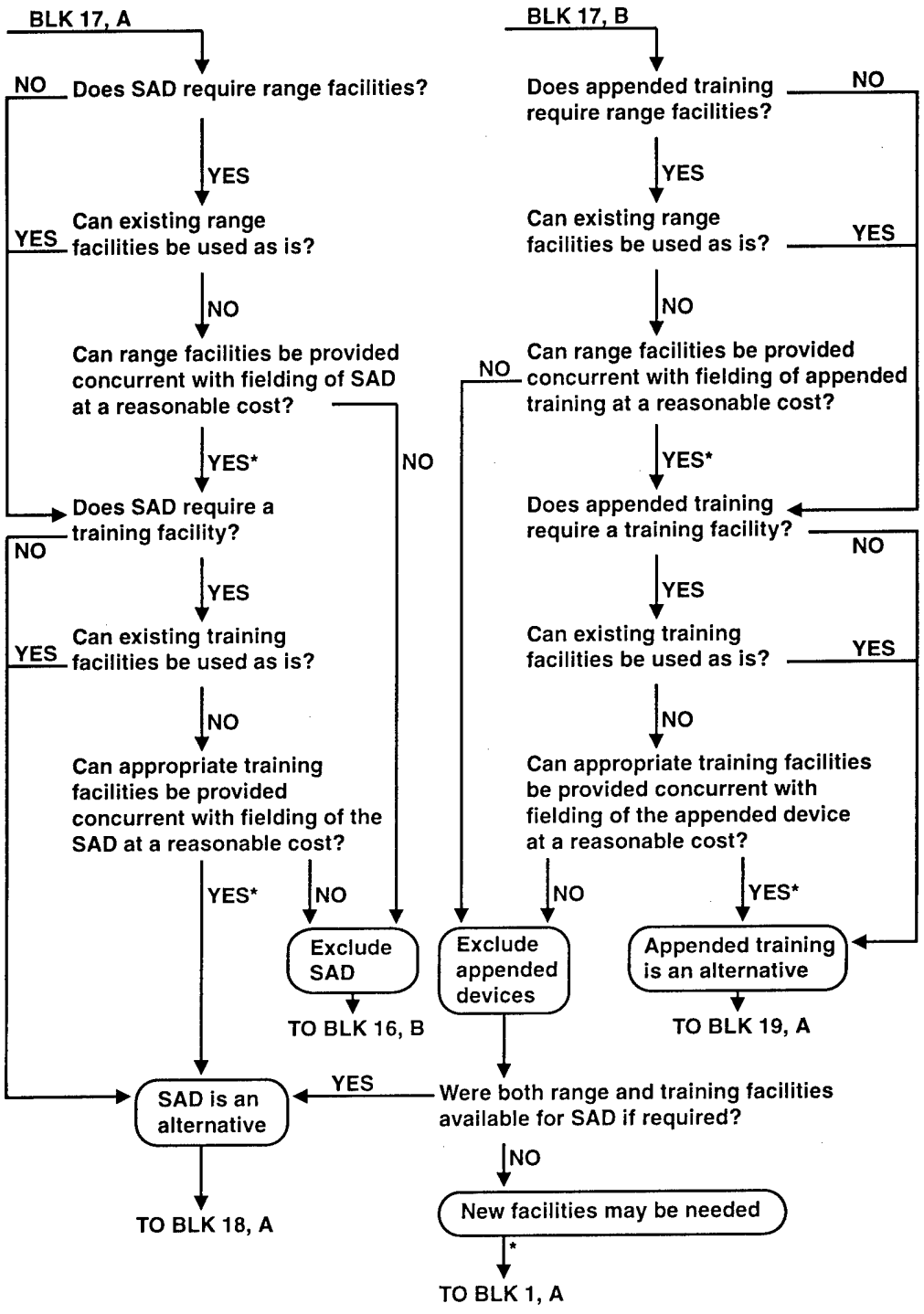
Phase III. Block 16 Help

Purpose: The purpose of this block is to identify factors that may limit or restrict the use of stand-alone devices (SADs) or appended training devices for meeting training requirements. Requirements documents may restrict the use of SADs or appended devices by limiting training support personnel (including those who support training as a secondary duty) or the number of training systems that are to be fielded.

Rationale: The effectiveness of a training device may be affected by the number of training systems fielded (which in turn affects the availability of the device) and the number and types of personnel available to support the fielded systems. If requirements documents fail to allocate a sufficient number of training devices or the personnel required to support them, then either training requirements must be reduced or the training device support must be increased. Increased support might consist of additional instructional or maintenance staff or an increase in the number of devices provided. If support cannot be increased, then requirements may have to be reduced. One way to reduce training requirements is to redesign the prime system so that less training is required to operate or maintain it. Requirements for additional instructional support can be reduced by automating many of the instructional functions, and requirements for maintenance support can be reduced by making the prime system more reliable and easier to maintain. Changing the support provided or requirements entails a reevaluation of Phase III, starting with Block 1 questions.

For training systems not restricted by constraints imposed in requirements documents, a dedicated Instructor/Operator must be available if needed unless other personnel are available to perform the necessary instructional functions, such as monitoring student performance and providing feedback. If personnel are not available to perform these functions, then a training device may still be an option if performance monitoring and feedback functions can be accomplished by designing a training device with automated instructor features. If a training device can meet the specific instructor requirements examined in this block, and it can satisfy other Manpower, Personnel, and Training (MPT) requirements, then the training device is considered further in Block 17. If not, the training device option being considered is excluded. If the device option excluded is SAD, then appended devices are considered in Block 16, B. If the appended device option cannot be adequately supported, and no other training system alternatives were recommended, then either training requirements must be reduced or support must be increased. Changing either support or requirements entails a reevaluation of Phase III, starting with Block 1 questions.

Phase III, Block 17. Will range and training facilities be available for SAD and appended training?



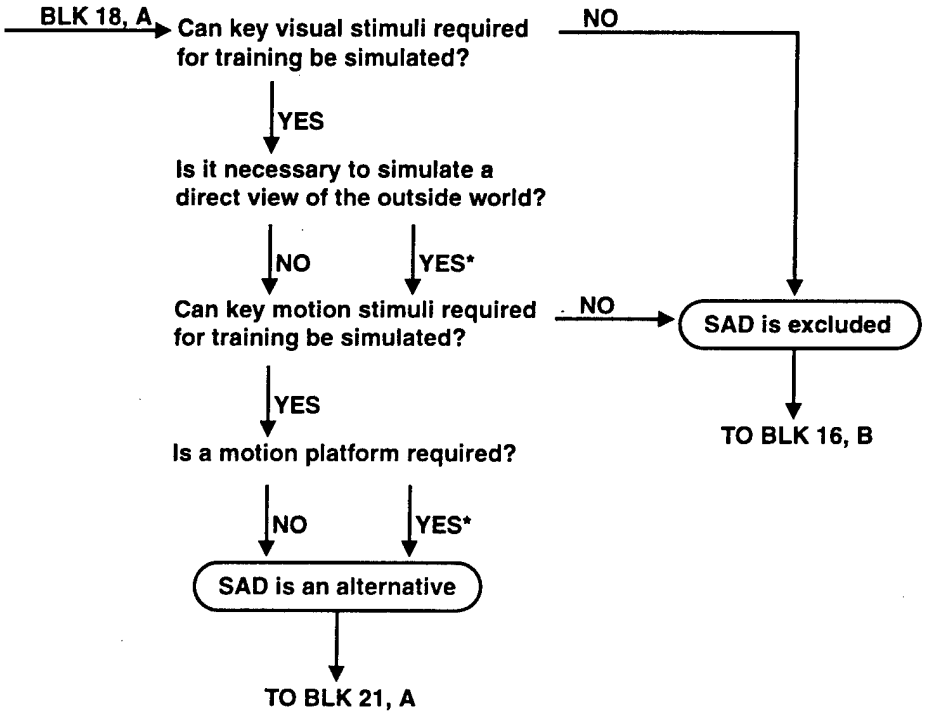
Phase III. Block 17 Help

Purpose: The purpose of this block is to determine whether the ranges and training facilities to support stand-alone or appended training devices will be available.

Rationale: If answers to questions in Block 16 indicate that the MPT support requirements for SADs can be met, then the availability of needed range facilities and other training facilities (e.g., buildings, equipment bays, portable enclosures) are determined. If the required facilities can be provided concurrent with fielding of the SAD at a reasonable cost, then stand-alone devices are an alternative to be considered further in Block 18. If facilities cannot be provided for SAD, then appended training is considered further in Block 16.

If answers to questions in Block 16 indicate that the MPT requirements can be met for appended training devices, then the analyst returns to Block 17 to assess the availability of needed range facilities and other training facilities for appended devices. If the required facilities can be provided concurrent with fielding of the appended device at a reasonable cost, then appended training devices are a training alternative to be considered further in Block 19. If the required facilities were available for neither stand-alone devices nor appended training, then new facilities may be needed. Following a decision to provide additional training facilities, the analyst must repeat the Phase III analysis after returning to Block 1.

Phase III, Block 18. Can weapon system motion and direct vision be simulated in a SAD?



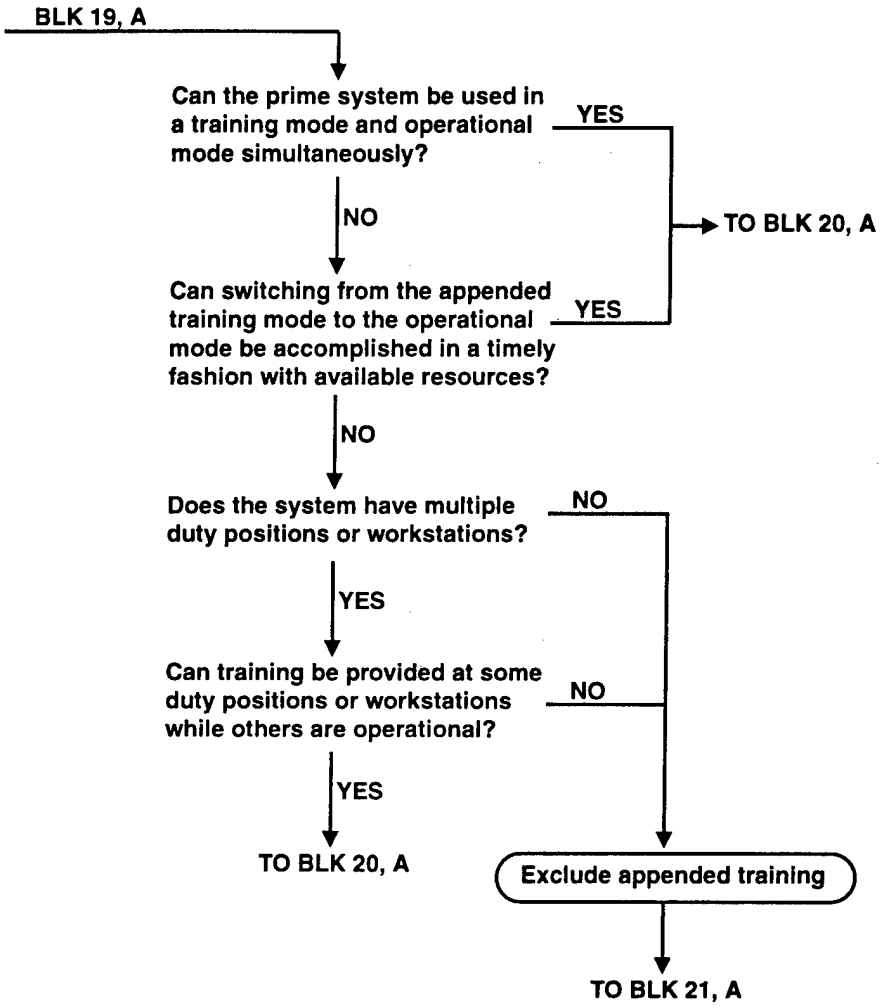
Phase III. Block 18 Help

Purpose: The purpose of this block is to determine how requirements for simulating visual or motion stimuli influence the selection of a stand-alone device (SAD) as a training system option.

Rationale: Requirements for simulation of real-world scenes and requirements for a motion platform to provide the motion cues may affect the selection of a stand-alone trainer. Requirements to provide extensive visual system and motion cues may also drive up the costs of the SAD. Identification of these cost drivers allows the analyst to reconsider the requirements that produced them. If key visual stimuli can be provided, then the need to simulate a direct view of the outside world is determined. If a direct view must be simulated, then the cost of the simulation is likely to be high. The capability of the training device to simulate key motion stimuli is then evaluated. If motion stimuli can be provided, the requirement for a motion platform is determined. The need for a motion platform also suggests that the simulation will be costly.

Key visual and motion stimuli are those stimuli that must be presented during training in order for the tasks to be performed and evaluated. If the key visual and motion stimuli can be provided, SAD is an alternative to be evaluated further in Block 21. If key stimuli cannot be provided, then SAD is excluded and appended training is evaluated in Block 16.

Phase III, Block 19. Would an appended training system interfere with prime system operation?

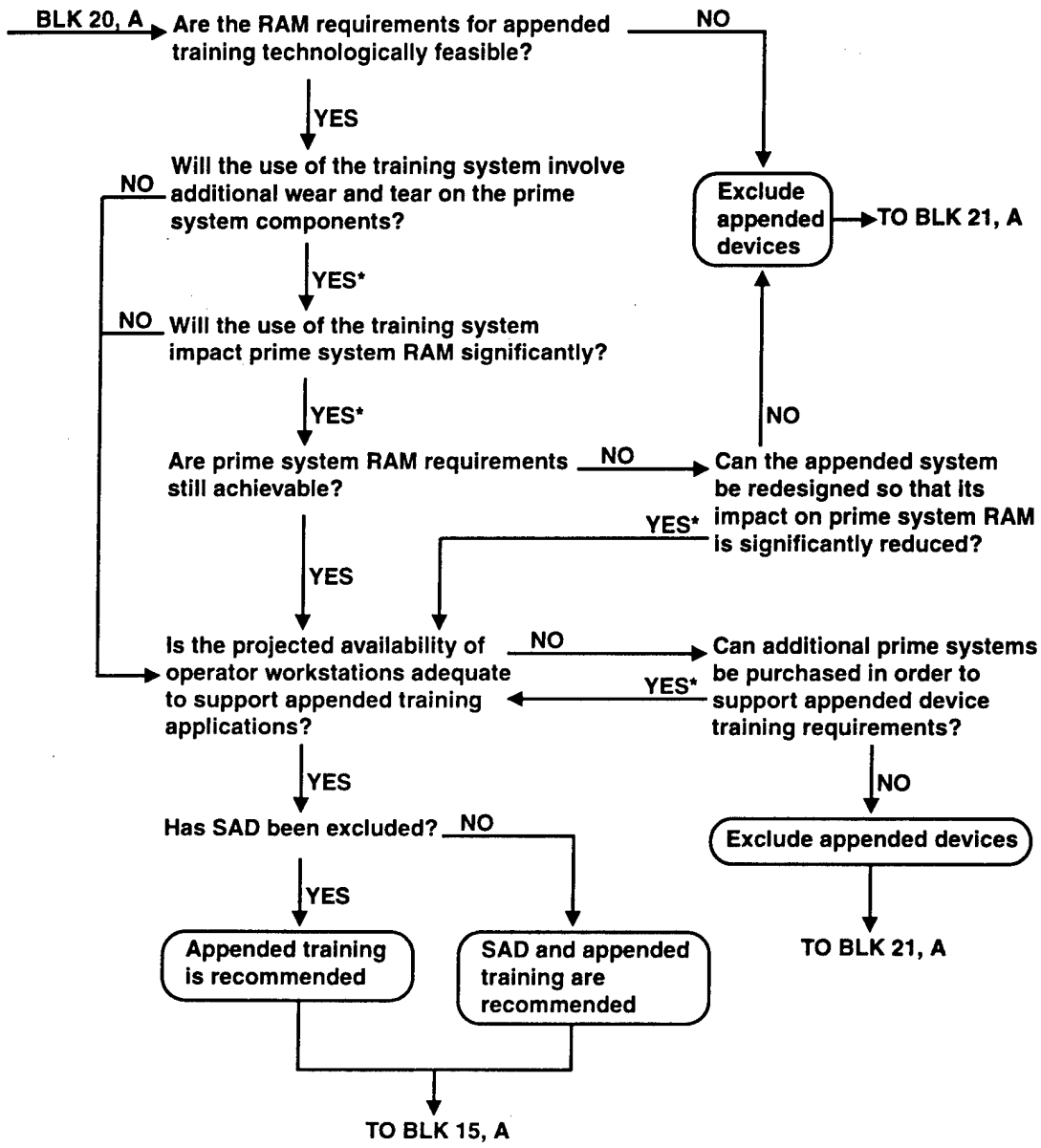


Phase III. Block 19 Help

Purpose: The primary purpose of this block is to determine how readily the prime system may be converted from use as an appended trainer to use as an operational system and vice versa. This block also explores the possibility that the prime system can be used for training and in an operational capacity simultaneously. Finally, for prime systems that have multiple duty positions or workstations, the feasibility of conducting appended training at one workstation while system operations are performed at another workstation is determined.

Rationale: Because the appended device option entails the use of prime system operator controls and displays, there is potentially a built-in conflict between using the prime system to perform its operational mission and employing it in its training role. If the prime system can be used for operations and training simultaneously, or if switching from the appended training mode to the operational mode can be done quickly, then there is no conflict and the appended device option is considered further in Block 20. If not, the possibility exists that training can be provided at some workstations while others remain operational. If this is the case, then the appended device option is considered further in Block 20. If none of these conditions can be met, then the appended device option is excluded and other training alternatives are evaluated in Block 21.

Phase III, Block 20.
Can appended training RAM requirements be met?
Can prime system availability meet training requirements?



Phase III. Block 20 Help

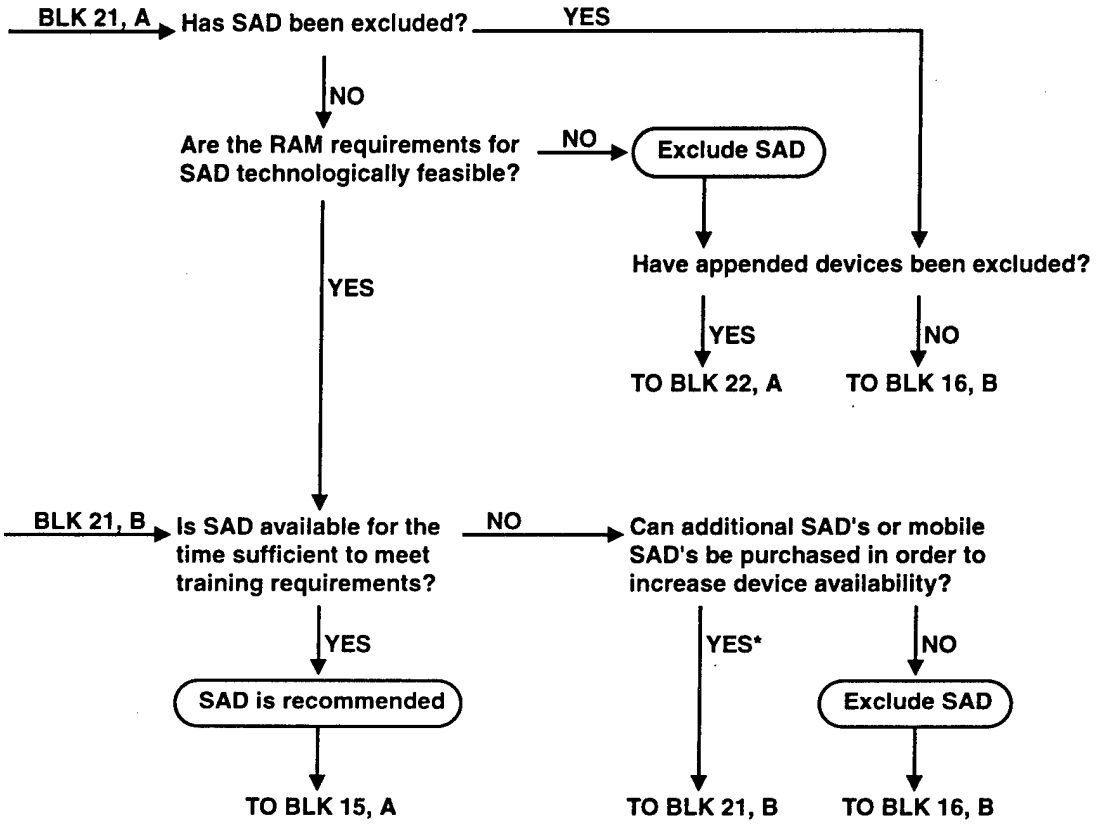
Purpose: The purpose of this block is to determine whether the Reliability, Availability, and Maintainability (RAM) requirements associated with the use of appended devices can be met. This block also evaluates the availability of the prime system to support the training requirements that must be satisfied by the appended training device.

Rationale: The components in an appended training system will be exposed to many of the same conditions as the prime system components, whereas a stand-alone device is not likely to be exposed to those conditions. Usage rates for the appended devices and SADs are also likely to differ. Hence, the RAM requirements for the two types of devices are likely to be different. If meeting the RAM requirements for an appended training device is not feasible, then the appended device option is excluded and the RAM requirements for SADs are considered in Block 21.

If appended device RAM requirements can be met, the impact of appended training on the prime system is evaluated. If the addition of appended devices involves additional wear and tear on prime system components so that RAM requirements cannot be met, then ways to redesign the appended system that result in less wear and tear on the prime system are considered. If all candidate appended systems impose unacceptable wear and tear on prime system components, RAM requirements for SADs are considered in Block 21. If including appended devices has no significant RAM impacts on prime system components or if RAM requirements can still be met (e.g., by redesigning the appended system), then the availability of prime system workstations for supporting appended device training is evaluated.

If prime system workstation availability is adequate or additional prime systems can be purchased in order to support appended training, then the appended training device option is recommended if SAD was previously excluded. If SAD has not been excluded, then both SAD and appended devices are recommended. If workstations are not available and cannot be provided for training, then appended devices are excluded from consideration and other training alternatives are considered in Block 21.

Phase III, Block 21.
Can SAD meet RAM and availability for training requirements?



Phase III. Block 21 Help

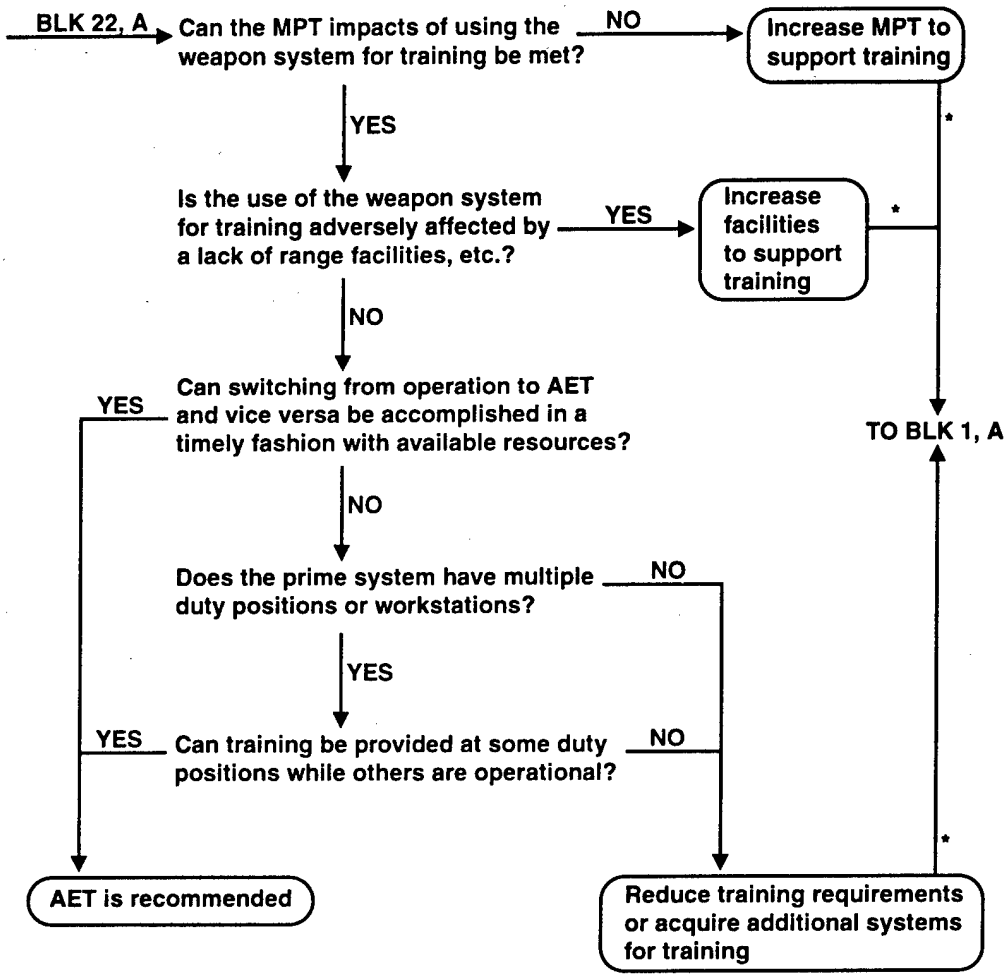
Purpose: The purpose of this block is to determine whether stand-alone devices (SADs) can meet the RAM requirements and training availability requirements.

Rationale: RAM requirements for SADs may differ from those of the prime system or from appended training devices. SADs may be located in a controlled environment so that SAD components may not be exposed to the harsh conditions to which the prime system is exposed. However, SAD components may be subject to high usage rates that may require more rugged components.

If SAD has not been previously excluded, the analyst should determine if meeting the RAM requirements for SAD is technologically feasible. If RAM requirements can be met, the availability of SAD for a sufficient time to meet training requirements is evaluated. If SAD can meet training requirements based on the expected usage rates and maintenance downtime, then SAD is recommended and the maintenance concept is explored in Block 15. If SAD availability cannot meet requirements, the possibility of purchasing additional SADs is explored. If the purchase of additional SADs can satisfy device availability requirements, SAD is recommended. Otherwise, SAD is excluded and appended training is considered in Block 16, B.

If SAD was previously excluded or excluded in this block because meeting SAD RAM requirements was not technically feasible, then the analyst must determine whether appended devices have also been excluded. If appended devices have been excluded, actual equipment training is considered in Block 22. If not, appended devices are considered beginning with Block 16, B.

Phase III, Block 22. Is Actual Equipment Training (AET) a workable alternative?



Phase III. Block 22 Help

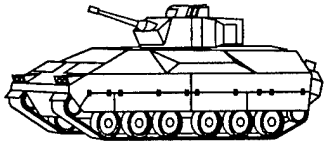
Purpose: The purpose of this block is to evaluate use of the actual equipment to satisfy the training requirements when embedded training and training device options are not able to satisfy the requirements.

Rationale: Training on the actual equipment without the benefit of training devices or embedded training has always been one alternative for meeting training requirements. Despite advances in training technology, some leaders still believe it is the most effective way to train their soldiers. In today's world of limited military budgets and constrained resources, however, it should typically be considered only when other alternatives have been ruled out.

In this block the analyst must determine whether actual equipment training (AET) can be supported. First, the analyst examines whether the Manpower, Personnel, and Training impacts of using AET can be met. That is, are personnel available who can develop and conduct AET and provide the necessary maintenance of the prime system? If MPT impacts can be accommodated, then the availability of adequate range facilities and other resources needed to support AET is determined. If either MPT impacts or range facilities are a problem, increased support may eliminate the problem. If support is increased, the analyst must reevaluate the training options by returning to Block 1.

If range facilities and other resources can support AET, the dual use of the system for combat operations and training is evaluated. If switching from operations to AET can be accomplished in a timely manner or if training can be provided at some duty stations while others are operational, AET is recommended. If operational use and training use of the prime system unavoidably conflict, then either training requirements must be reduced or system availability for training must be increased. One way to increase prime system availability for training is to acquire more systems. Training requirements can be reduced by redesigning the prime system operator interface or reducing training standards. Following the decision to acquire additional prime systems or to reduce training requirements, the analyst must redo the analysis beginning at Block 1.

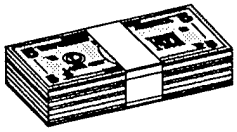
SECTION 7.
SIMULATION-BASED TRAINING ALTERNATIVE COST SUMMARY



TRAINING COSTS

ET

AET



SAD

APPENDED

SIMULATION-BASED TRAINING ALTERNATIVE COST SUMMARY

The Training Alternative Cost Summary requires the completion of a cost estimating worksheet, rather than a series of flowcharts as do the other phases. That worksheet is provided in this section. It is designed to facilitate the comparison of simulation-based training alternatives in terms of four different kinds of costs:

- Design and Development Costs
- Procurement Costs
- Maintenance Costs
- Operations Costs

It is designed to be completed in conjunction with the Phase III and IV analyses, although it could be completed earlier if the necessary information were available. The cost comparisons reflect increasing detail and certainty in the later phases. Preparation of the worksheet will in most cases by a joint effort on the part of the training developer and STRICOM. Cost worksheet preparation will require resourcing data from the program/project manager (PM) for the prime system and the preparer will need to work closely with the PM to develop accurate cost estimates.

Design and Development costs are those one-time costs incurred prior to the production of the actual prime systems or training devices. Procurement costs are those one-time costs associated with actually obtaining and fielding the training systems. Maintenance costs are those costs incurred to keep the training systems in an operating condition. Operation costs are the other recurring costs required to deliver the training. Maintenance and Operations costs are recurring costs and need to be considered over the life cycle of the training system.

While the worksheet shows column headings for AET, Appended Training, SAD, and the three types of ET (fully embedded, appended, and umbilical), it is expected that a worksheet column will be completed only for training alternatives that have been recommended in the preceding phases of the analysis.

The questions asked on the worksheet should not be considered exhaustive. Rather, it is intended that they suggest other cost factors on which training alternatives may differ for the specific situation under consideration. The costs

considered are for the training subsystem of the prime system, not for the entire prime system.

The most difficult problem to be addressed is the interpretation of the cost data. If the alternatives being compared are equally effective, and the same number of units of each alternative are to be acquired, either the total cost of the acquisition or the cost per training system is a valid basis for comparison. However, if training systems differ in terms of effectiveness, and different numbers of training systems would therefore be acquired under different alternatives, the problem becomes more complex. The issue then becomes not just one of cost, but one of cost effectiveness. The least expensive alternative is the best only if the alternatives are equivalent in effectiveness.

COST CATEGORIES	AET	APPENDED	EMBEDDED TRAINING			SAD
			FULLY	APPENDED	UMBILICAL	
Design & Development. What is the cost of designing and developing the training subsystem for each training alternative? Consider the following:	$____	$____	$____	$____	$____	$____
What is the cost of designing new (or upgraded) ranges and facilities?	$____	$____	$____	$____	$____	$____
What is the development cost of the training management system? Consider how complex the management of the training is expected to be. Include management of individual and crew progress, assignment of training sequences, scheduling of training, and scheduling and ordering of all support personnel and materials.	$____	$____	$____	$____	$____	$____
What are the costs of developing supporting documentation (e.g., Instructor/Operator manual, maintenance manuals, etc.)?	$____	$____	$____	$____	$____	$____
What are the courseware development costs?	$____	$____	$____	$____	$____	$____
Does the training alternative require the development of complex simulations? If so, do these simulations require a direct view of the outside world?						
Is the courseware development required within the "state of the art"?						
Does the training require that the simulations function in an interconnected network?						
Must the hardware and software interact with system components that provide simulated motion (e.g., a motion platform)?						

Figure 4. Training alternative cost summary.

COST CATEGORIES	AET	APPENDED	EMBEDDED TRAINING			SAD
			FULLY	APPENDED	UMBILICAL	
Design & Development. (continued)						
What are the hardware and software development costs?	$____	$____	$____	$____	$____	$____
Does the training require that the simulations function in an interconnected network?						
Must the hardware and software interact with system components that provide simulated motion (e.g., a motion platform)?						
Is training system component ruggedization required?						
Is training system component miniaturization required?						
What development, if any, is required to reduce the safety risks associated with the training events to an acceptable level? What is the cost of that development?	$____	$____	$____	$____	$____	$____
What is the developmental cost of the additional interface capabilities required to support ET? Consider the following:	$____	$____	$____	$____	$____	$____
Will additional controls and displays be required to provide ET? Include both controls and displays required for the student, and for the Instructor/Operator. What is the cost?	$____	$____	$____	$____	$____	$____
Does the system need additional instrumentation solely to support embedded training? What is the cost?	$____	$____	$____	$____	$____	$____
Will existing controls or other components need to be hardened or ruggedized to withstand the additional demands of training? What is the cost?	$____	$____	$____	$____	$____	$____

Figure 4. Training alternative cost summary (continued).

COST CATEGORIES	AET	APPENDED	EMBEDDED TRAINING			SAD
			FULLY	APPENDED	UMBILICAL	
Procurement. What is the cost of acquiring the training system for each training alternative? Consider the following:	$____	$____	$____	$____	$____	$____
What is the cost of the construction of new (or upgrading current) ranges and facilities?	$____	$____	$____	$____	$____	$____
Are additional prime systems required solely for the purpose of providing embedded training? If so, what is the cost of the additional prime systems required? (Note that this question refers to prime systems, not training systems.)	$____	$____	$____	$____	$____	$____
What is the per unit acquisition cost of each training system alternative? How many are required?	$____	$____	$____	$____	$____	$____
Is a hardware or software retrofit necessary for either training delivery or training management? If so, what is the cost?	$____	$____	$____	$____	$____	$____
If transportation of the training system is necessary, are specialized vans or trailers required? If so, what is the cost?	$____	$____	$____	$____	$____	$____
Is support equipment, such as power supplies or generators required? If so, what is the cost?	$____	$____	$____	$____	$____	$____

Figure 4. Training alternative cost summary (continued).

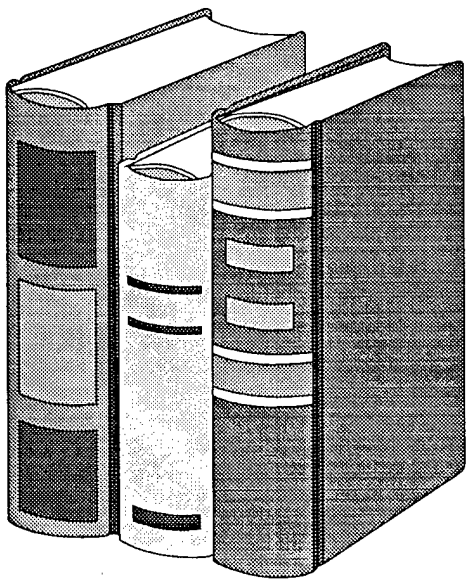
COST CATEGORIES	AET	APPENDED	EMBEDDED TRAINING			SAD
			FULLY	APPENDED	UMBILICAL	
Maintenance (Annual). What is the annual cost of maintaining each training alternative? Consider the following?	$____	$____	$____	$____	$____	$____
What is the estimated cost of maintaining the training system or subsystem hardware, software, and documentation for each training alternative? Include the costs of updating. Consider how stable prime system software and training courseware are expected to remain during the post-deployment period.	$____	$____	$____	$____	$____	$____
Are there demonstrated or anticipated increases in RAM due to the beneficial impacts of ET or SAD on operator or maintainer performance? If so, what are the expected cost savings?	$____	$____	$____	$____	$____	$____
What additional costs, in terms of manpower and materiel, will be created by the wear and tear on the prime system caused by training use?	$____	$____	$____	$____	$____	$____
What cost savings, in terms of manpower and materiel, will be created by a reduction in the wear and tear on the prime system caused by reduced use of the prime system for training?	$____	$____	$____	$____	$____	$____

Figure 4. Training alternative cost summary (continued).

COST CATEGORIES	AET	APPENDED	EMBEDDED TRAINING			SAD
			FULLY	APPENDED	UMBILICAL	
Operations (Annual). What is the annual operation and support cost for each training alternative? Consider the following:	$____	$____	$____	$____	$____	$____
What is the estimated cost of the required additional training (such as Instructor/Operator training) and training support personnel (including salaries) for each training alternative?	$____	$____	$____	$____	$____	$____
What are the training facilities operating costs for each training alternative?	$____	$____	$____	$____	$____	$____
What are the consumable resource costs (e.g., fuel, ammunition, electricity, etc.) for each training alternative?	$____	$____	$____	$____	$____	$____
Are there quantifiable costs or savings resulting from the safety risks or benefits associated with each alternative? If so, what are they?	$____	$____	$____	$____	$____	$____
Are there costs, not included elsewhere, that result from the need to move or transport the training system, students, or training support personnel for the purposes of conducting training? If so, what are they?	$____	$____	$____	$____	$____	$____

Figure 4. Training alternative cost summary (continued).

SECTION 8.
REFERENCES



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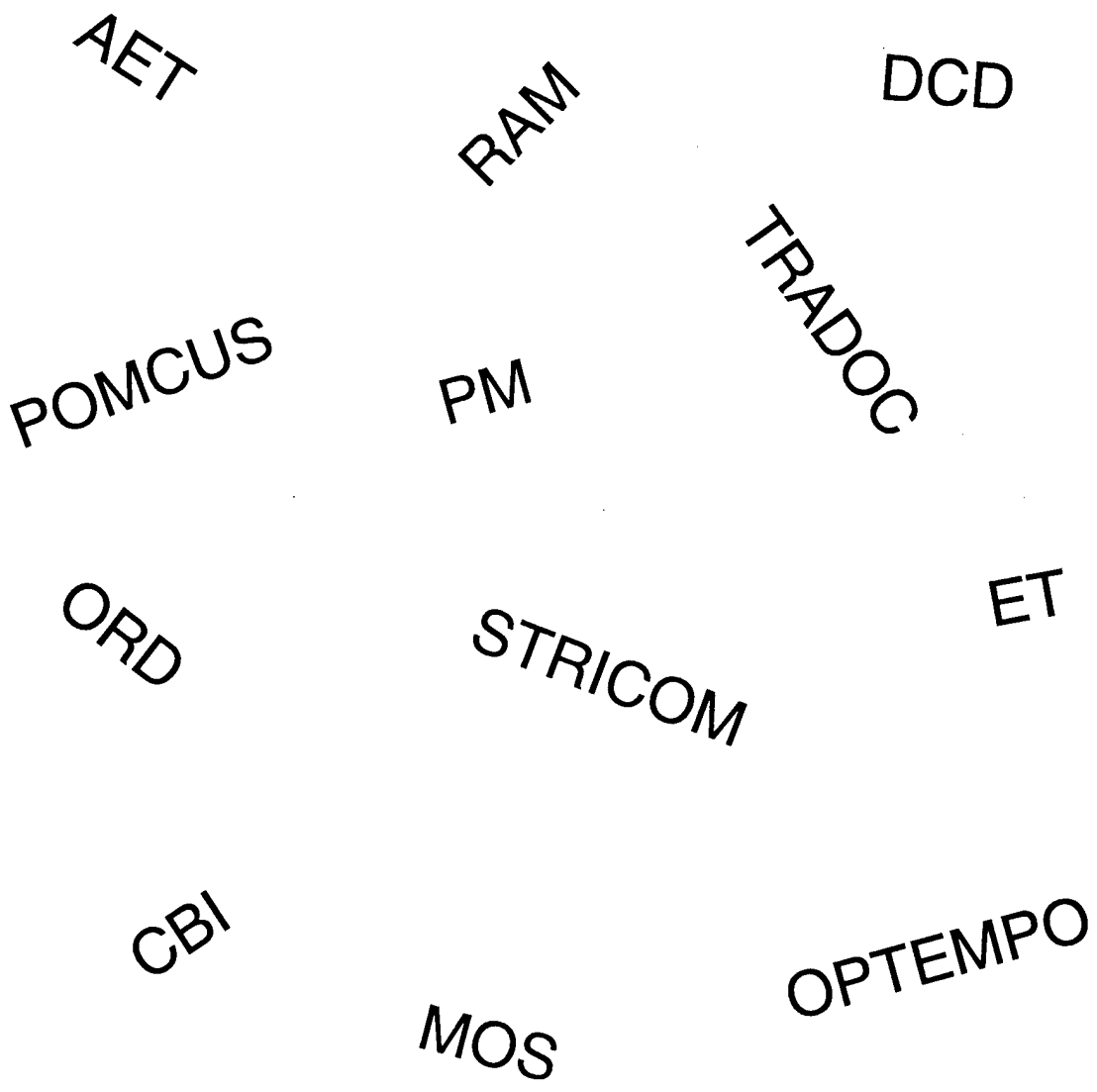
SECTION 9.
LIST OF ACRONYMS



LIST OF ACRONYMS

AET	Actual Equipment Training
CBI	Computer-Based Instruction
DA	Department of the Army
DCD	Directorate of Combat Developments
DOTD	Directorate of Training and Doctrine
ET	Embedded Training
Instr/Op	Instructor/Operator
MOS	Military Occupational Specialty
MPT	Manpower, Personnel, and Training
OPTEMPO	Operating Tempo
ORD	Operational Requirements Document
PM	Project Manager
PM TRADE	U.S. Army Project Manager for Training Devices
POMCUS	Prepositioning of Materiel Configured to Unit Sets
RAM	Reliability, Availability, and Maintainability
SAD	Stand-Alone Devices
STRAP	System Training Plan
STRICOM	Simulation, Training and Instrumentation Command
TACS	Training Analysis Cost Summary
TRADOC	U.S. Army Training and Doctrine Command

APPENDIX A. ET CONSIDERATION FACTORS

This Appendix contains a listing and description of ten factors that were used in generating and grouping the questions for the decision charts. These factors are useful in making decisions about what training should be embedded. The factors are policy; training environment; system availability for training; training content; technical feasibility; reliability, availability, and maintainability; manpower, personnel, and training support requirements; training-specific interface requirements; safety; and effectiveness relative to alternatives. The factors are a revised version of those identified by Strasel et al. (1988).

Each factor may have up to three subfactors which reflect the requirement, opportunity, and cost dimensions of each factor. Requirements are high-level mission, conceptual, and mission-based factors, which are relatively independent of the prime system. Opportunities are feasible occasions for the use of a particular training medium. Costs are the life-cycle costs of both the prime system and the training system. A matrix which shows factors and the subfactor dimensions considered in each phase is included as Figure A-1. Subfactor dimensions were used to identify and organize questions for inclusion in the decision charts. Not all factors consist of all three subfactors. Technical feasibility has no cost subfactor. Training-specific interface requirements and effectiveness relative to alternatives each have only one cost subfactor. This occurs because some subfactors either were not logically sound (i.e., the opportunity for a training-specific interface requirement) or duplicated other subfactors (i.e., technical feasibility-cost duplicates other cost subfactors).

Policy. Relevant policy consists of conceptual-level statements or decisions about the requirements, opportunities, or costs of ET. (1) Policy—requirements: Policy about requirements may range from very general statements ("will do") to more detailed statements of what is to be accomplished with embedded training. Policy about requirements may also constrain other resources (e.g., reduced OPTEMPO, no new ranges) so that there are fewer alternatives to ET. (2) Policy—opportunities: Policy may indicate opportunities for the use of embedded training (e.g., emphasis on the need for "force-on-force" training). (3) Policy—costs: Policy may also indicate or constrain the cost of the total training system, embedded training, or other training components.

Training Environment. Subfactors are (1) Environment—requirements, who is to be trained to do what, when, and at what location; (2) Environment—

opportunity, nodes in the training environment at which the prime equipment, trainees, and other major training facilities are or can readily be collocated; and (3) Environment—cost, the major cost drivers of training in the proposed environment (e.g., facilities, instructor personnel).

Prime System Availability for Training. Subfactors are (1) Availability—requirements, the amount of time that the prime system needs to be available for training in order to satisfy training requirements; (2) Availability—opportunity, the amount of time during which the prime system can be made available for use as a trainer and still satisfy its prime (combat) mission; and (3) Availability—cost, the life-cycle cost of the additional prime systems (if any) that are required to satisfy the embedded training requirements.

Training Content. Subfactors are (1) Content—requirements, the nature of the tasks and skills to be trained; (2) Content—opportunity, the extent to which the materials to be trained are amenable to delivery and performance assessment via the prime system; and (3) Content—cost, the life-cycle cost of developing, modifying, and maintaining the courseware and other required training materials.

Technical Feasibility. Subfactors are: (1) Feasibility—requirements, the extent to which available or projected technology will permit the stated requirements for embedded training to be met; and (2) Feasibility—opportunity, the extent to which the hardware and software characteristics of the prime system permit or facilitate presentation of task-related stimuli and measurement of student performance. Technical feasibility includes the assessment of technical risk.

Reliability, Availability, and Maintainability (RAM). Subfactors are (1) RAM—requirements, RAM requirements for both the prime system and the embedded training system; (2) RAM—opportunity, the need for ruggedized or more reliable components to satisfy the demands of embedded training; and (3) RAM—cost, the change in the life-cycle cost of the prime system resulting from the change in usage caused by ET.

Manpower, Personnel, and Training (MPT) Support Requirements. Subfactors are (1) MPT—requirements, limits or demands placed on the training system in terms of number of personnel to be made available, the skills those personnel can or must have, and the training that they will require; (2) MPT—opportunity, MPT resources available with the equipment to conduct or support ET; and (3) MPT—cost, the cost of the additional manpower (military, civilian, or contract) required to support the embedded training system, as training managers, instructors, and maintainers. The last subfactor includes the cost of training for government personnel.

Training-Specific Interface Requirements. Interface requirements—cost: This factor consists of the life-cycle costs of the hardware and software enhancements to the prime system (additional computer memory, image generators, instructor operator station) which are required to provide training for each

training element to be embedded. This includes the cost of appended and umbilical components, but not the cost of the courseware itself.

Safety. Subfactors are (1) Safety—requirements, the need to reduce accidents or safety risks during training; (2) Safety—opportunity, system characteristics and design solutions which increase or decrease the level of risk of using the embedded training system to conduct task training; and (3) Safety—cost, the life-cycle cost of any actions (hardware, software, training, etc.) required to reduce the safety risk generated by the embedded system to an acceptable level.

Effectiveness Relative to Alternatives. Effectiveness—cost: This factor consists of a comparison of the leading training alternatives for training each of the training elements in terms of estimated cost and effectiveness.

Figure A-1 shows which factors and subfactors are considered in each of the first four phases of the embedded training decision process.

Factor	Phases in Which Considered			
	I	II	III & IV	TACS
Policy				
Requirements	X			
Opportunity	X			
Cost	X			
Training Environment				
Requirements		X		
Opportunity		X		
Cost		X		X
Prime System Availability for Training				
Requirements	X	X	X	
Opportunity		X	X	
Cost			X	X
Training Content				
Requirements	X	X	X	
Opportunity		X	X	
Cost				X
Technical Feasibility				
Requirements			X	
Opportunity			X	
Reliability, Availability, & Maintainability				
Requirements			X	
Opportunity		X	X	
Cost				X
MPT Support Requirements				
Requirements	X		X	
Opportunity		X	X	
Cost				X
Training-Specific Interface Requirements				
Cost				X
Safety				
Requirements	X		X	
Opportunity		X	X	
Cost				X
Effectiveness Relative to Alternatives				
Cost			X	X

Figure A-1. Factors considered in each of the four phases of the analysis and the simulation-based training alternative cost summary (TACS)